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Musée national des sciences naturelles
Musées nationaux du Canada

Ottawa

PROCEEDINGS OF 1981 WORKSHOP ON CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS

Daniel J. Faber, Editor

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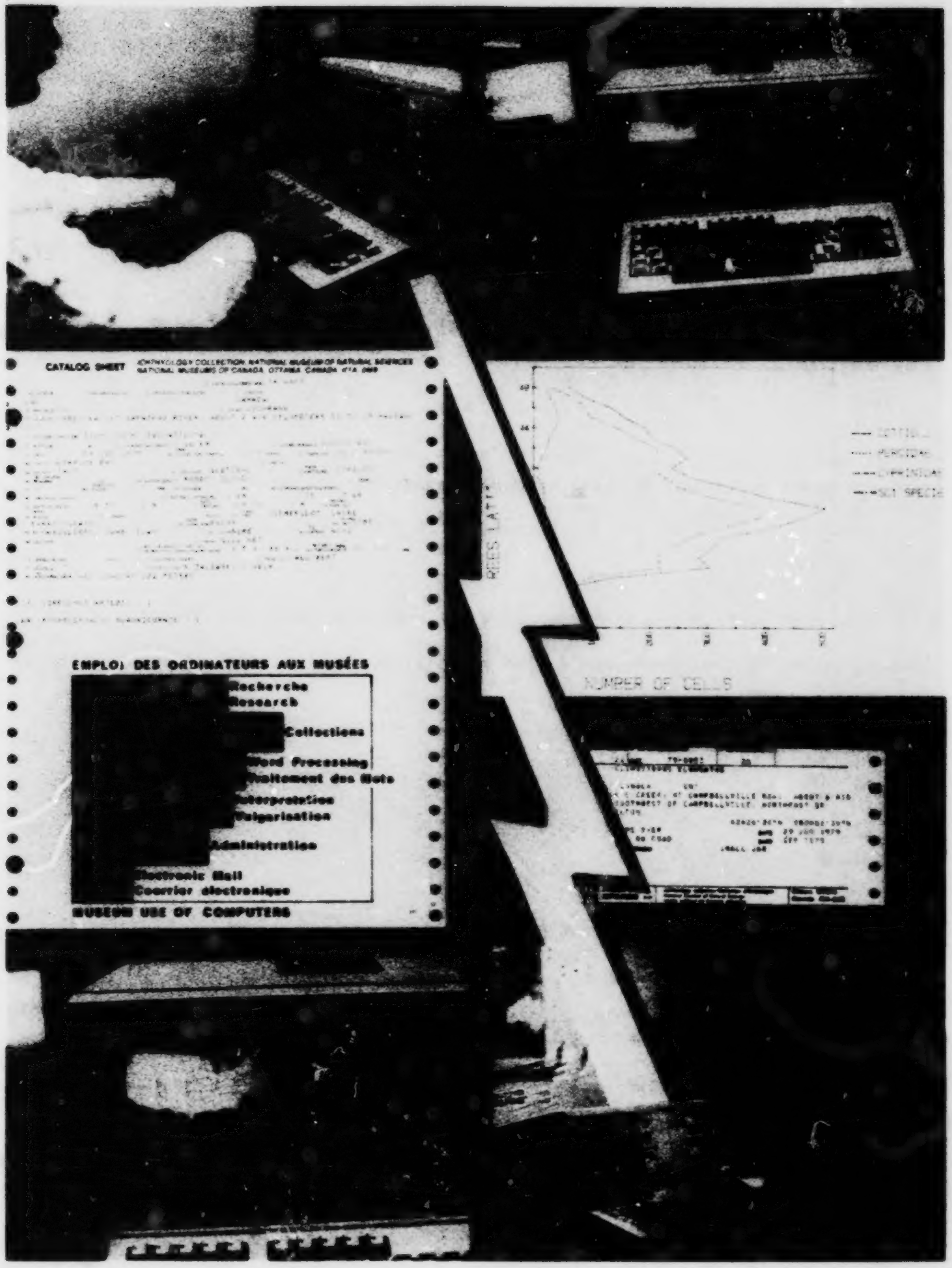
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Uses for computers in natural history collection work
(photos, courtesy D.E. McAllister)

L'usage des ordinateurs dans les travaux de collections d'histoire naturelle
(photos, D.E. McAllister)

PROCEEDINGS OF 1981 WORKSHOP ON CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS

Daniel J. Faber, Editor

The National Museum of Natural Sciences sponsored this 1981 workshop which was organized and carried out by D.J. Faber and G.R. Fitzgerald.

Le Musée national des sciences naturelles a subventionné cet Atelier tenu en 1981; il a été organisé par D.J. Faber et G.R. Fitzgerald, qui en ont aussi compilé les travaux.

Syllogeus No. 44

National Museums of Natural Sciences
National Museums of Canada

Musée national des sciences naturelles
Musées nationaux du Canada

Ottawa, 1983

These Proceedings of the 1981 workshop are dedicated to the late Harold L. (Hank) Shearman, former staff member of the Division of Vertebrate Palaeontology, who spoke about such a publication during the late 1960's.

Les travaux de l'Atelier sont dédiés à feu Harold L. (Hank) Shearman, employé de la Section de la paléontologie des vertébrés, qui avait d'ailleurs eu l'idée d'une telle publication vers la fin des années 60.

FORWARD

One important aspect of museum work is the management of collections. For natural history museums, that includes collecting, preparing and preserving specimens, documentation and storage. Most museums house extensive collections that grow indefinitely. The high cost of storage space and the fact that many specimens are irreplaceable (some species become rare or extinct, also collecting is becoming increasingly restricted) make it imperative that museums seek and adopt the best techniques and methods of managing their collections in the most efficient, practical and secure way possible.

Natural history museums, perhaps because of their long tradition, tend to rely upon established procedures which, although generally satisfactory, leave much room for improvement. Some preservatives damage tissues or are unpleasant to users; glass containers are fragile; specimens in cabinet drawers are rattled each time the drawer is opened and shut; fumigation is a risky procedure; etc.

Prompted by these considerations and with the hope of stimulating interest in those matters, the National Museum of Natural Sciences asked one of its scientists, Dr. D.J. Faber, to find out if colleagues might agree to participate in a workshop on collections' management. The response was enthusiastic and a highly successful meeting took place in Ottawa in May, 1981. It was decided that the proceedings would be published and that there should be follow-ups at the international and national levels. It is now up to all of us to ensure that continued progress be made.

Louis Lemieux
Former Director
National Museum of Natural Sciences
Ottawa

PREFACE

Un aspect important de la muséologie est la gestion des collections. Pour un musée d'histoire naturelle, ceci comprend la collecte, la préparation et la préservation des spécimens, la documentation et le rangement. La plupart des musées abritent des collections considérables, qui ne cessent d'augmenter. Les coûts élevés de l'espace de rangement et le fait que plusieurs spécimens sont irremplaçables (Certaines espèces deviennent rares ou disparaissent et les restrictions sur la collecte s'avèrent de plus en plus sévères.) font qu'il est impérieux que les musées recherchent et adoptent les meilleures techniques et méthodes leur permettant de gérer leurs collections d'une façon pratique, efficace et sécuritaire.

Une longue tradition incite peut-être les musées à perpétuer des procédures qui, bien qu'elles soient généralement satisfaisantes, gagneraient à être améliorées. Certains préservatifs endommagent les tissus ou sont déplaisants à manipuler, les contenants en verre sont fragiles, les spécimens rangés dans les cabinets sont secoués chaque fois que les tiroirs sont tirés et poussés, les fumigations comportent des risques, etc.

Conscient de cet état de choses et dans l'espoir de stimuler l'intérêt à ce sujet, le Musée national des sciences naturelles a demandé à l'un de ses scientifiques, Monsieur D.J. Faber, de déterminer si d'autres muséologues canadiens consentiraient à participer à un colloque sur la gestion des collections. La réponse fut enthousiaste et une excellente réunion eut lieu à Ottawa en juin 1981. Il fut alors décidé que le texte des communications serait publié et qu'on s'efforcerait de poursuivre les entretiens sur les plans international et national. Il appartient maintenant à chacun de nous d'assurer le progrès de cette entreprise.

Louis Lemieux
Ex-directeur
Musée national des sciences naturelles
Ottawa

CONTENTS

Page

DEDICATION / DEDICACE 2

FORWARD 3

PREFACE 4

PREFACE 8

AVANT-PROPOS 11

ACKNOWLEDGEMENTS 14

REMERCIEMENTS 15

COLLECTION OF SPECIMENS / CUEILLETTE DES SPECIMENS

A light trap to sample littoral and limnetic regions of lakes.
D. FABER 17

Some new methods of collecting small insects.
L. MASNER 19

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

The potentials of diatirology.
C. ROMERO-SIERRA and J. WEBB 21

Osteological preparation techniques used by the Zooarchaeological Identification Centre.
S. CUMBAA 29

The preparation of leech specimens: relaxation is the key to preservation.
J. MADILL 37

Vapour degreasing. A new technique for degreasing and cleaning entomological specimens.
W. McKILLOP and W. PRESTON 43

A technique for the preparation of specimens of the meninges of the brain.
C. ROMERO-SIERRA, J. DRISCOLL, W. LYONS and P. LANE 45

An overview of formalin techniques for the fixation of cadavera.
C. ROMERO-SIERRA, P. LANE and W. LYONS 49

Techniques for the preparation of whole brain specimens.
C. ROMERO-SIERRA, W. LYONS, J. DRISCOLL, P. LANE and J.C. WEBB 53

Preservation of biological specimens by freeze-drying techniques.
C. ROMERO-SIERRA, J. WEBB, P. LANE and W. LYONS 57

Page

Freeze-drying at the Nova Scotia Museum.
B. WRIGHT 65

STORAGE OF SPECIMENS / RANGEMENT DES SPECIMENS

Glycerin as a preservative for immature insects.
P.T. DANG 69

A storage system to reduce the exposure of animal collections to light.
D. FABER 71

The wet-epoxy-surface technique of casting with pour-in-place polyurethane foam.
G. FITZGERALD 75

Casting fossil footprints in a limited-access time location.
R. GRANTHAM 79

Storing insect specimens in gelatin capsules.
A. HAMILTON 89

Relocation of the Royal Ontario Museum's invertebrate palaeontology collections, 1981.
J. WADDINGTON and D. RUDKIN 93

The prevention of humidity-related phase transitions in mineral specimens.
R. WALLER 103

DOCUMENTATION OF SPECIMENS / DOCUMENTATION DES SPECIMENS

An introduction to minicomputers in museums.
D. McALLISTER 105

Data processing applications: the right machine for the right job.
P. HOMULUS 137

Photographs for collection documentation.
P. LAMBERT, A. PEDEN and B. COOKE 141

Colour measurement of entomological specimens.
W. McKILLOP and W. PRESTON 143

Computerization of the herbarium of the University of British Columbia.
J. PINDER-MOSS 145

MISCELLANEOUS / DIVERS

Regional collections and the concept of regional centres.
H. DANKS 151

Plants: from the field to the herbarium.
J. GILLETT 161

Page

Why should a museum maintain a large collection?
D. LAUBITZ, C.T. SHIH and I. SUTHERLAND 169

The involvement of the International Council of Museums in collection's management.
L. LEMIEUX 173

Techniques to restore dried-up invertebrate specimens.
L. MARHUE 175

Natural history collections at the Regina Research Station.
M. MOLLOY 179

Comparisons of zooarchaeological and classical osteological collections.
A. RICK 183

APPENDIX A. SELECTED BIBLIOGRAPHY ON CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS 185

ANNEXE A. BIBLIOGRAPHIE SELECTIVE SUR LA PREPARATION ET LA PRESERVATION DES COLLECTIONS D'HISTOIRE NATURELLE 187

APPENDIX B. REPORT ON QUESTIONNAIRE CONCERNING CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS 193

ANNEXE B. COMPTE RENDU DU SONDAGE SUR LA PREPARATION ET LA CONSERVATION DES COLLECTIONS D'HISTOIRE NATURELLE 195

PREFACE

Natural history collections are maintained coast to coast by a wide variety of Canadian institutions including museums, government agencies, universities, and private firms. These collections which are cared for by persons of varying skills and knowledge, ranging from highly trained specialists to volunteers, include not only natural history specimens but also collection data and specimen-related materials such as slides, films, and sound recordings. Every specimen represents an investment of time and money and if it was originally collected for a valid reason, then it should be preserved rather than allowed to decay. Hopes of collecting certain specimens again in the future may never be realized and therefore conservation of existing specimens will be the way for museums in the future.

Natural history collections stored within Canadian institutions comprise a valuable Canadian National Heritage that are not well documented or even known outside the institution of ownership. The scope of the problem is shown in a recent report produced by the National Inventory Programme of the National Museums of Canada (Jewett, D.F., 1981. Survey of Collections in Canadian Institutions, 6 p., 4 tables, 8 appendices, National Inventory Programme, National Museums of Canada, Ottawa). This report showed that 1,909,940 natural history artifacts are held in Type "A" institutions (museums and art galleries) and that only 0.06% of these records are available in National Inventory Programme storage files. These records do not even include important natural history collections housed in universities or other government institutions, such as the more than 10,000,000 specimens held in the Canadian National Collection of Insects. One thing is evident, the numbers and diversity of Canadian natural history specimens with associated materials is immense.

Scientists hold regular meetings to discuss progress within their individual disciplines but time is rarely devoted to problems relating to care of specimens or collections. Day to day interactions between institutions are normally too infrequent to disseminate the necessary information, let alone stimulate further creative ideas. Compounding this normal suppression of information is the fact that persons who actually care for collections are not usually financially able to attend regular scientific meetings.

It is evident that we have problems in not knowing how to best care for our natural history collections and in not knowing their true extent. These problems are compounded by the fact that we are seldom able to get together to specifically discuss problems relating to collections.

In recognition of these problems, the National Museum of Natural Sciences distributed nationally a questionnaire to explore the possibilities of holding an interdisciplinary meeting dealing with the techniques for care and maintenance of natural history collections. A summary of the replies that we received during November and December, 1980, is shown in Appendix B. These results were encouraging and we were further prompted by a newly developed Collections Policy of the National Museums of Canada (National Museums of Canada 1981. Collections Policy and Procedures. *Codex Musealis* No. 1, 93 pp.), which proposed a modern view of responsibility for collections held by the National Museums of Canada (page 31):

> "10901. Responsibility for Protection. The collections of the Corporation and its National Museums are their principal assets. These assets, unlike the buildings which house them, are mostly of an irreplaceable kind representing the products of nature and the works of man from former eras, often the only remaining evidence of past cultures or phenomena. Therefore, the Corporation and its National Museums have a responsibility to the people of Canada and to the rest of the world to maintain their collections at a standard commensurate with their importance and value. There are three elements to protection of collections: conservation, security, housing and environment."

Therefore the National Museum of Natural Sciences organized and hosted the "1981 Workshop on Care and Maintenance of Natural History Collections".

The Workshop was held on 27 and 28 May, 1981, in Marion Hall on the campus of the University of Ottawa as an adjunct session of the Annual Convention of the Canadian Museums Association. Over 90 participants attended from all provinces except Prince Edward Island. Keynote speakers were Dr. Caesar Romero-Sierra, Queen's University, speaking on "Potentials of Diatirology" and Dr. Donald McAllister, National Museum of Natural Sciences, speaking on "An Introduction to Minicomputers in Museums". Eighteen other contributed papers of varying subjects were presented and six poster papers were displayed. Tours were conducted to the National Herbarium, the Zooarchaeological Identification Centre, the Paleobiology Division, and the National Collection of Beetles at the Biosystematics Research Institute. Storage systems to hold collections were displayed by Dompro Ltd. and Williams and Wilson Ltd. Other displays of interest included: the results of preservation research being performed at Queen's University; publications from the Biosystematics Research Institute, Agriculture Canada and Lyman Entomological Research Institute, McGill University; and, a selected bibliography relating to care and maintenance of natural history collections (Appendix A).

During the final hour of the Workshop most speakers agreed to transform their oral presentations into written manuscripts for publication in a proposed "Proceedings of 1981 Workshop on Care and Maintenance of Natural History Collections". Moreover, Dr. Louis Lemieux had agreed "in principle" to support the publication of a Proceedings in some National Museum of Natural Sciences publication. The participants also gave general support and encouragement to have another similar Collection Workshop in 1984 for which Dan Faber agreed to accept the responsibility, as pro tem Chairman, to locate a time and place.

We strongly feel that an interdisciplinary, crossfertilized approach, such as occurred at this workshop, will produce effective results more quickly than can be achieved by a multitude of caretakers working in isolation within their specialized disciplines. Workshops on the care and maintenance of natural history collections should be continued in Canada in order to provide an educational continuum for those persons responsible for natural history artifacts. At this time of increasing awareness of our National Heritage, it is essential to communicate the necessary technical information needed to properly care and maintain irreplaceable products of nature.

D.J. Faber and G.R. Fitzgerald

AVANT-PROPOS

Une grande variété d'établissements d'un bout à l'autre du Canada - musées, organismes gouvernementaux, universités et entreprises privées - conservent des collections de sciences naturelles. Ces collections, dont le soin est confié à des personnes de compétence et de formation diverses, du spécialiste hautement qualifié au bénévole, contiennent non seulement des spécimens de plantes et d'animaux, mais aussi des pièces liées au domaine des sciences naturelles telles que diapositives, films, enregistrements sonores et diverses autres pièces de collection. Chaque spécimen représente un investissement de temps et d'argent et ceux qui ont été collectionnés pour un motif valable méritent d'échapper à la décomposition. Comme certains de ces spécimens ne pourront peut-être jamais plus être retrouvés, il importe, qu'à l'avenir, les musées s'adonnent à la conservation des spécimens dont on dispose actuellement.

Les collections d'histoire naturelle conservées dans les établissements canadiens constituent une partie précieuse du patrimoine national qui est mal documentée et mal connue a l'extérieur des établissements propriétaires. Un rapport publié récemment par le Programme du répertoire national des collections des Musées nationaux du Canada (Jewett, D.F., 1981. Survey of Collections in Canadian Institutions, 6p., 4 tableaux, 8 annexes, Programme du répertoire national des collections, Musées nationaux du Canada, Ottawa), révèle que 1 909 940 pièces d'histoire naturelle sont conservées dans des établissements de type A (musées) et que seulement 0,06% de ces pièces sont recensées dans les dossiers du Programme. Ces statistiques ne rendent même pas compte des collections importantes d'histoire naturelle qu'abritent les universités et les établissements gouvernementaux autres que les musées. Mentionnons à cet égard les dix millions de spécimens de la collection nationale d'insectes. Chose certaine, la variété ainsi que le nombre de spécimens et de pièces connexes qui composent les collections canadiennes sont immenses.

Les scientifiques se réunissent régulièrement pour discuter des progrès réalisés dans leurs disciplines, mais il est malheureusement rare qu'ils abordent le problème des soins à donner aux spécimens et aux collections. Les échanges entre établissements sont d'ordinaire trop rares pour permettre la diffusion de l'information nécessaire et, à plus forte raison, pour stimuler l'éclosion d'idées nouvelles. A cela s'ajoute le fait que les personnes qui se préoccupent de l'état des collections n'ont pas les moyens d'assister régulièrement à des réunions scientifiques.

Conscient de ces problèmes, le Musée national des sciences naturelles a diffusé à travers le pays un questionnaire en vue d'examiner la possibilité de tenir des réunions interdisciplinaires consacrées à l'étude des techniques de préparation et d'entretien des collections d'histoire naturelle. Les réponses reçues au cours des mois de novembre et décembre 1980 figurent à l'annexe B. Elles sont encourageantes et s'inscrivent dans la récente politique en matière de collections adoptée par les Musées nationaux du Canada (Musées nationaux du Canada, 1981. Politique et plans d'action en matière de collections. Codex Musealis, n° 1, 93 p.), qui reflète une conception moderne de la responsabilité à l'égard des collections conservées par les Musées nationaux du Canada (Codex Musealis n° 1, p. 31):

> "10901. Responsabilité de la protection. Les collections des Musées nationaux et de ses éléments sont leurs principaux biens. Ces biens, contrairement aux bâtiments qui les abritent, sont pour la plupart irremplaçables, car ils représentent les produits de la nature et les oeuvres de l'Homme datant de périodes anciennes, souvent les derniers vestiges de cultures ou de phénomènes du passé. C'est pourquoi les Musées nationaux et ses éléments sont responsables envers les Canadiens et le reste du monde de maintenir leurs collections à un niveau conforme à leur importance et à leur valeur. Il existe trois éléments dans la protection des collections: la conservation, la sécurité, et les locaux et l'environnement."

Le Musée national des sciences naturelles a donc organisé et accueilli l'Atelier 1981 sur le soin et la préparation des collections d'histoire naturelle. Il s'est tenu les 27 et 28 mai au pavillon Marion de l'Université d'Ottawa, à titre de séance annexe de la Convention annuelle de l'Association des musées canadiens. Plus de 90 représentants de toutes les provinces, à l'exception de l'Ile-du-Prince-Edouard, y ont participé.

Les principaux conférenciers furent M. Caesar Romero-Sierra de l'université Queen, qui a abordé la question de la diatirologie et M. Donald MacAllister du Musée national des sciences naturelles qui a parlé d'un système de micro-ordinateur pour le musée. Dix-huit autres documents portant sur diverses questions ont été présentés et six affiches ont été exposées. On avait prévu des visites à l'Herbier national, au Centre d'identification zooarchéologique, à la Division de la paléobiologie, ainsi qu'à la Collection nationale de coléoptères de l'Institut de recherches biosystématiques. Des systèmes d'entreposage des collections ont été présentés par les compagnies Dompro Ltd. et Williams and Wilson Ltd. Il a également été question du résultat des recherches sur la préservation menées à l'université Queen; des publications de l'Institut de recherches biosystématiques (Agriculture Canada) et de l'Institut de recherches entomologiques Lyman de l'université McGill; il a aussi été fait mention d'un choix d'ouvrages portant sur la préparation et la préservation des collections d'histoire naturelle (annexe A).

Pendant la dernière heure de l'Atelier, la plupart des conférenciers ont accepté de transcrire leurs exposés oraux sous forme de manuscrits. Par ailleurs, M. Louis Lemieux a accepté en principe d'appuyer la publication d'un compte rendu dans l'une des publications du Musée national des sciences naturelles. Dan Faber, à titre de président provisoire, a accepté de fixer le lieu et la date d'un prochain atelier sur le même thème, en 1984.

Grâce à cette expérience, il est très probable qu'une approche conjuguée des problèmes de conservation produira des résultats plus rapides et plus efficaces que les efforts isolés d'une multitude de spécialistes cantonnés dans leur domaine. Il serait bon que l'on continue à tenir au Canada des ateliers sur le soin et la préparation des collections d'histoire naturelle en vue d'assurer la formation continue de personnes responsables de la conservation des pièces d'histoire naturelle. A une époque où la conscience de l'importance de notre patrimoine national ne cesse de croître, il devient essentiel de diffuser les renseignements techniques nécessaires pour assurer le soin et la préparation d'éléments irremplaçables de la nature.

D.J. Faber et G.R. Fitzgerald

ACKNOWLEDGEMENTS

Deepest thanks and appreciation is extended to Dr. Louis Lemieux, former Director of the National Museum of Natural Sciences, for providing staff and funds for the planning and running of the Workshop. He displayed considerable insight by encouraging and allowing an unproven idea to germinate, grow, and burst forth in bloom. Mr. F. Hugh Schultz and Mr. C.G. Gruchy, Acting Directors of the Museum, have given continued support for the publication of the Proceedings. Thanks to Canadian Museums Association for the meeting rooms at the University of Ottawa; to Ken Edmonds, Dompro Ltd., and Ross Contant, Williams and Wilson Ltd., for providing refreshments; to the Royal Bank, the Toronto Dominion Bank, and Canada's Capital Visitors' and Convention Bureau for providing pens, pencils, notebooks, maps and brochures. Special appreciation is extended to the University Women's Club of Ottawa, including Freda Araujo, Joanne Faber, Lillian Gertsman and Murial Williams for volunteering to run the registration desk. And thanks to Mike Shchepanek for the collection-related bibliography; to Bob Waller for setting up the poster papers; to Louise L. Trahan for editing the french text; to Jack Martin for arranging for the tour at the Biosystematics Research Institute; to Drs. D. Keith McE. Kevan and George E. Lammers for help with the paper session; and to Joanne Faber, Rolande Gaulin, Gail Rice, Joyce Tynan-Byrd, and Jan McConnell and staff of the Word Processing Centre for typing assistance.

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Nous tenons à exprimer nos vifs remerciements et notre gratitude à M. Louis Lemieux, ex-directeur du Musée national des sciences naturelles, pour avoir fourni le personnel et les fonds nécessaires à la planification et à la bonne marche de l'Atelier. Il a fait preuve d'une grande clairvoyance en autorisant et en encourageant la formation, le développement et l'épanouissement d'une idée dont la valeur restait encore à démontrer. Messieurs H.F. Schultz et C.G. Gruchy, directeurs intérimaire du Musée, ont pour leur part contribué à l'entreprise en fournissant les fonds nécessaires à la publication du compte rendu des travaux. Nous remercions l'Association des musées canadiens d'avoir assumé les frais de location des salles de réunion de l'Université d'Ottawa. Nous désirons également remercier Ken Edmonds de la Dompro Ltd. et Ross Contant de la Williams and Wilson Ltd. d'avoir fourni les rafraîchissements, ainsi que la Banque Royale, la Banque Toronto Dominion et l'Office du tourisme et des congrès de la Capitale du Canada d'avoir fourni les stylos, crayons, blocs-notes, cartes et brochures. Nous sommes particulièrement reconnaissants au Centre universitaire des femmes et en particulier à Freda Araujo, Joanne Faber, Lillian Gertsman et Murial Williams d'avoir bien voulu s'occuper du comptoir des inscriptions. Nous tenons à remercier Mike Shchepanek pour la bibliographie qu'il a dressée du domaine des collections; Bob Waller pour la composition des affiches; Louise L. Trahan pour la révision des textes français; Jack Martin pour avoir organisé la visite de l'Institut de recherches biosystématiques; Drs. D. Keith McE. Kevan et George E. Lammers qui ont bien voulu présider les séances de l'atelier, ainsi que Joanne Faber, Rolande Gaulin, Gail Rice, Joyce Tynan-Byrd, et Jan McConnell et le personnel du Centre de traitement des mots pour leur travail de dactylographie.

COLLECTION OF SPECIMENS / CUEILLETTE DES SPECIMENS

A LIGHT TRAP TO SAMPLE LITTORAL AND LIMNETIC REGIONS OF LAKES

Daniel J. Faber

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FABER, D.J. 1983. A light trap to sample littoral and limnetic regions of lakes. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 17-18.

ABSTRACT- (Faber, D.J. 1981. A light trap to sample littoral and limnetic regions of lakes. VERH. INT. VER. LIMNOL. 21:744-749, one figure, two tables, no abstract). A light trap was designed to be used in all areas of lakes and ponds. This light trap, which was constructed mainly from Plexiglass, consisted of an upper light chamber, a lower animal chamber, a cylindrical section of fine-mesh netting, and a small collection bucket. Four rectangular openings (95 mm x 3 mm) allowed animals, which were attracted to light, to enter the animal chamber from four directions. A 6-volt battery powered a small incandescent bulb whose illumination was measured at 2.2 lux at one meter away. The kinds of animals taken by the light trap included: Acarina, Amphipoda, Cladocera, Copepoda (Calanoida and Cyclopoida), Insecta (Coleoptera, Diptera, Ephemeroptera, Hemiptera and Trichoptera), Mysidacea, Oligochaeta, and Ostracoda. In one experiment, light traps were set along the outer edge of a shoreline bed of *Scirpus* between 2200 and 2400 hours during June and July, 1980, for two time periods, 15 and 30 minutes. Results suggested that 15 minutes was enough to determine the relative abundance of most animal groups. Thirty-minute sets usually trapped more than double the number of animals collected with 15-minute sets. In another experiment a determination of the seasonal succession of animal groups within the bed of *Scirpus* was attempted during June and July, 1980, using 60-minute sets. These results showed that Cladocera, Acarina and Cyclopoida dominated the samples, although ten other groups appeared in smaller numbers. The numbers of animals collected showed considerable variation from week to week.

RESUME- (Faber, D.J., 1981. A light trap to sample littoral and limnetic regions of lakes. VERH. INT. VER. LIMNOL. 21: 744-749, une figure, deux tableaux, sans résumé). Un piège lumineux a été conçu pour être utilisé dans toutes les zones des lacs et des étangs. Fabriqué en grande partie en plexiglas, il comprenait un compartiment supérieur pour le foyer lumineux, un compartiment inférieur pour les animaux, une partie cylindrique constituée d'un réseau de mailles fines et un petit collecteur. Quatre ouvertures rectangulaires (95 mm x 3 mm) permettaient aux animaux attirés par la lumière d'entrer de quatre côtés différents dans le compartiment qui leur était réservé. Une pile de 6 volts alimentait une petite ampoule à lumière incandescente dont l'éclairement a été estimé à 2,2 lux, à un mètre de distance. Parmi les différents types d'animaux capturés au moyen du piège lumineux, mentionnons: Acariens, Amphipodes, Cladocères, Copépodes (Calanidés et Cyclopidés), Insectes (Coléoptères,

Diptères, Ephéméroptères, Hémiptères et Trichoptères), Mysidacés, Oligochètes et Ostracodes. Dans le cadre d'une expérience, des pièges lumineux ont été déposés le long de la bordure extérieure d'un massif littoral de *Scirpus*, entre 22 h et 24 h, durant les mois de juin et juillet 1980, pour deux périodes, l'une de 15 minutes et l'autre de 30 minutes. Les résultats semblaient indiquer qu'une période de 15 minutes était suffisante pour déterminer l'abondance relative de la plupart des groupes d'animaux. Les périodes de 30 minutes permettaient en général d'attraper plus du double des animaux récoltés pendant les périodes de 15 minutes. Dans une autre expérience, on a tenté de déterminer, sur des périodes de 60 minutes en juin et juillet 1980, la succession des groupes d'animaux selon les saisons dans le massif de *Scirpus*. On s'est aperçu que les Cladocères, les Acariens et les Cyclopidés étaient les principaux groupes représentés dans les échantillons, mais que dix autres groupes y figuraient en nombre inférieur. Le nombre d'animaux récoltés variait beaucoup d'une semaine à l'autre.

SOME NEW METHODS OF COLLECTING SMALL INSECTS

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MASNER, L. 1983. Some new methods of collecting small insects. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 19-20.

ABSTRACT- Classical collecting methods for insects are normally aimed at collecting larger insect specimens. Certain smaller insects, such as the parasitic microhymenoptera (Chalcidoidea, Proctotrupoidea, Cynipoidea) are not well represented in these catches. Their small sizes (ca. 1mm), fast escape strategies, and delicate structures are obstacles to collecting them. Four devices were described and their uses discussed: (1) A "separation bag" was designed to hold live insects in a closed chamber with a transparent lid (Masner, L. and G.A.P. Gibson 1979. The separation bag, a new device to aid in collecting insects. CAN.ENT. 111:1197-8). Small insects are aspirated through a small opening in the bottom of the cloth bag. This device has proved ideal for assessing certain habitats for fast-moving, smaller insects. (2) An "interception trap" was designed to capture low flying insects (Masner, L. and H. Goulet 1981. A new model of flight-interception trap for some hymenopterous insects. ENT.NEWS 92(5):199-202). A pyrethroid-treated (e.g., Ambush) polyester barrier with a plastic roof as a rain cap is suspended between two trees. A plastic trough placed below the barrier and filled with saline solution with a touch of surfactant functions as the pan trap. (3) A "screen sweeper" has recently been designed to capture small insects in large numbers (Masner, L. unpublished). A 1/4 in wire mesh screening placed near the top of a sweeping net eliminates most plant debris. The contents of the net are transferred into a plastic bag containing small amounts of wet salt (NaCl). (4) A "rapid retrieval dish" has recently been designed to extract smaller insects from various sampling gear (Masner, L. unpublished). All the debris and insects which have been screened by different sized screen meshes can be carefully examined under a microscope in these square plastic retrieval dishes which are subdivided by plexiglass septa. This device allows careful and rapid sorting of large volumes of material preserved in alcohol.

RESUME- Les méthodes classiques de collecte des insectes sont généralement destinées à capturer de gros spécimens. Certains insectes plus petits, tels que les microhyménoptères parasites (Chalcidoïdés, Proctotrupoïdés, Cynipoïdés) ne constituent qu'une faible part de ces captures. Leur petite taille (environ 1 mm), leur vitesse de fuite et leur structure délicate ne favorisent pas leur capture. Ouatre dispositifs sont décrits ainsi que leur mode d'utilisation: 1) Un "sac séparateur" a été conçu pour conserver les insectes vivants dans un compartiment fermé muni d'un couvercle transparent (Masner, L. et G.A.P. Gibson, 1979. The separation bag, a new device to aid in collecting insects. CAN. ENT. 111: 1197-1198). Les

petits insectes sont aspirés par une petite ouverture dans le bas d'un sac de toile. Ce dispositif s'est révélé parfaitement adapté aux études sur la présence de petits insectes très rapides dans certains habitats. 2) Un "dispositif d'interception" a été conçu pour capturer les insectes se déplaçant près du sol (Masner, L. et H. Goulet, 1981. A new model of flight-interception trap for some hymenopterous insects. ENT. NEWS, sous presse). On étend entre deux arbres une bande de polyester traitée au pyréthroïde (par ex., Ambush) et surmontée d'un toit en plastique pour arrêter la pluie. Une sorte d'auge en plastique, placée sous la bande et remplie d'une solution saline avec une petite quantité de surfactant, recueille les insectes. 3) Un "filet à filtre" a été récemment conçu pour capturer de grandes quantités de petits insectes (Masner, L., inédit). Un treillis métallique à mailles de 1/4 po, installé près du sommet d'un filet, élimine la plupart des débris végétaux. Le contenu du filet est transféré dans un sac en plastique qui contient de petites quantités de sel humide (NaCl). 4) Un "plateau de récupération rapide" a été récemment inventé pour récupérer de petits insectes capturés au moyen de divers dispositifs d'échantillonnage (Masner, L., inédit). Tous les débris et les insectes qui ont été tamisés au moyen de filtres de différentes tailles peuvent être examinés attentivement au microscope dans ces plateaux carrés de récupération en plastique, subdivisés par des cloisons de plexiglas. Ce dispositif permet de trier avec précision et rapidité de grandes quantités de matériel conservé dans l'alcool.

THE POTENTIALS OF DIATIROLOGY[1]

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ROMERO-SIERRA, C. and J.C. WEBB. 1983. The potentials of diatirology. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 21-28.

ABSTRACT- An analysis of accomplishments made hitherto in diatirology, the science of preservation, is presented, taking as point of reference the ancient art of mummification of the Egyptians. Reasons for the unimpressive achievements throughout history are suggested. Comments are made on the present perspectives of this scientific field and the strategies to pursue in its future development.

RESUME- Il s'agit d'une analyse des réalisations faites jusqu'ici en "diatirologie" ou science de la conservation, le point de référence étant l'art ancien de la momification chez les Egyptiens. On y avance les raisons qui peuvent expliquer le peu de succès obtenu dans ce domaine au cours de l'histoire. La communication présente quelques observations sur les perspectives actuelles dans cette discipline scientifique et propose des stratégies pour l'avenir.

INTRODUCTION

Everyone knowledgeable of the history of the sciences is aware of their generally cohesive growth patterns with the interspersed appearance of gaps in knowledge pertaining to certain fields, which for whatever reasons have not moved ahead in step with other scientific developments. In this article our concern is precisely with such a field, i.e., *diatirology* or science of preservation, where retardation in growth is obvious. Diatirology derives its name from the Greek and was coined by A. Beal in 1979.

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[1] This paper constitutes one part of the keynote address given by Dr. Romero-Sierra at the Workshop. Other parts include: "A technique for the preparation of specimens of the meninges of the brain", "An overview of formalin techniques for the fixation of cadavera", "Techniques for the preparation of whole brain specimens" and "Preservation of biological specimens by freeze-drying techniques".

In trying to delineate the historical boundaries of diatirology - in search of an explanation for this gap - we find that closely related areas have continued growing, e.g., art conservation, histology and histochemistry, all of which have developed uninterruptedly on solid and technological grounds. Upon scrutiny of the historical development in these areas, one can recognize that they fail to deal with problems involving whole biological organisms. It would seem that whole organisms are too much to handle and that these disciplines prefer to deal with bits and pieces. In another related area, i.e., food preservation, imperative consumer and producer needs have motivated the growth and development of sophisticated industrial technology.

At the heart of preservation are two defined areas: taxidermy and the art of mummification. Taxidermy has developed, in the hands of a few, into a craft that requires considerable skill and, in the hands of even fewer, into an art that demands the creative talents of a true artist. Taxidermists have never claimed that their territory is a science. However, their particular and important knowledge enriches the biological sciences and must not be disregarded, as it might well have fed upon facts and findings that have been missed in scientific biological studies. Quite apart from this, taxidermy, of course, stands on its own merits as an expression of human endeavor.

A science of the preservation of whole biological specimens simply does not exist. In the past, animal species have become extinct almost on a daily basis, and the only records of their existence that we are left with are drawings, pictures, written descriptions or, at best, pickled specimens in poor and distorted shapes. Hence, the richest of all legacies, our biological heritage, is being lost with indifference, resignation and possibly some indignation. According to the reasoning expressed here, priority should be given to those people concerned with the problem of keeping species alive on earth. However, as second best, those species whose survival escapes our efforts ought to be preserved as best as humanly possible.

Perhaps the most important contributions in collecting and studying biological specimens have been made by curators. Unfortunately, they labour under unfavorable conditions with the unavailability of optimal preservation techniques, thus collections in their care are consequently prone to deterioration. Efforts of many dedicated curators have been totally wasted on these grounds.

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

MUMMIFICATION

Methods for the preservation of dead bodies by embalming and other procedures were effectively developed by the Egyptians. Five major procedural steps were followed in the treatment of dead bodies of the wealthy ruling class. Subsequently, the Greeks and the Romans tried to imitate this art of the Egyptians. However, they were unsuccessful since they failed to include all of the five principal steps; they restricted their work to only two or three of them.

The sequence of the five principal steps is as follows:

1) Removal of blood and other body fluids and introduction of new fluids by perfusion,
2) Evisceration,
3) Covering the body with salts (curing) or keeping the body in a brine at different temperatures,
4) Application of oils, balsams, balms, tar, etc.,
5) Wrapping the body tightly in layers of cloths impregnated with tar or oils.

Only the bodies of the wealthiest and most powerful members of society received this full five-step treatment. With the highest ranking members, e.g., the Pharaohs, this treatment was carried out with utmost care and diligence. For example, at the time of evisceration, the brain was extracted from the skull, viscera cleaned and immersed in oils in special containers and the costliest balsams were used in abundance. In light of the prevailing conditions during their times, the achievements of the Egyptians must be recognized as extraordinary. The knowledge that the Egyptians possessed, in regards to embalming, is always referred to as an art in itself. Science, however, in its broadest sense is knowledge about facts.

If we judge from our times the quality of specimens preserved by the Egyptians, we find the majority of them deceptive. Very few remains constitute evidence of what has earned them their overwhelming fame. Other preserved bodies, besides those mummified by the Egyptians, worthy at least of mention, were prepared by the Guanches (original inhabitants of Canary Islands).

Throughout the course of history, preserved whole organisms of even higher quality and of older age than Egyptian mummies have been found in different regions of the world. These regions where mummies have been found have certain environmental characteristics which categorize the areas:

1) Ice (icelands),

2) Salty sand (Desert of Atacama),

3) Volcanic lava (Italy),

4) Bogs (Britain, Denmark).

CAUSES UNDERLYING THE LACK OF SCIENTIFIC ADVANCES IN DIATIROLOGY

There are sufficient reasons to believe that it is difficult to develop scientific methods to preserve whole biological specimens because:

1) there seem to be too many variables,

2) there is no body of consolidated knowledge of a scientific nature,

3) as a consequence of (2), there are no Masters of the craft, no Disciples nor even a "School of Thought."

Anyone, who has dared to contribute in earnest to this field, has most frequently been treated as a second-rate scientist, whose contributions are either rejected or accepted only in obscure or inappropriate publications. Most preservation work is delegated to technical personnel with minimal expectations that "old routine methods" are known to provide. When ingenious and eager technicians have tried to improve preservation techniques, they have for the most part been discouraged by lack of adequate support. One finds now and then some beautiful old specimens in museum collections without any records describing how they were treated. One wonders if they came about by chance, or if they are products of a mastered technique still unrecognized.

The opposition of the scientific community and the lack of support on the part of many administrators have been and still are the main factors inhibiting the growth of knowledge in this area. Hence, the factors that cause this inhibition are mainly:

4) inertia in the scientific community,

5) bigotry of scientists,

6) lack of foresight on the part of administrators.

It would be ridiculous to view these ideas as a condemnation of existing circumstances. Taken as intended, these remarks only point out that we can improve the situation.

There is another subtle matter that contributes in some measure to the unsatisfactory growth of diatirology. We can call it:

7) misconceptions.

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

It is commonly believed that mummification had in ancient times reached such a level of perfection that there is no need nor room for additional discoveries. In other words, it appears that a consensus dictates that there is no merit in learning more about preserving biological specimens, because it was already accomplished successfully by others many centuries ago. This conception is far from the truth, and this can be said without taking away the well deserved merit from the Egyptian civilization during times of the Pharaohs. These seven factors contribute to the fact that diatirology is lagging behind times and there may well be others. The mere awareness of any such cause contributes a first step towards its rectification.

THE METHODOLOGY OF PRESERVATION OF BIOLOGICAL SPECIMENS

Anatomists learned from the Egyptians the essence of preservation, expanded the rationale, which they based on principles of physics, chemistry and biology, and simplified the procedures. The subsequent discovery of more powerful chemicals for preservation established a rudimentary pool of knowledge that was useful for simple and/or practical objectives. The different methodologies used in the preservation of whole biological specimens can be grouped as follows:

A) Freezing
B) Dehydrating - drying by heat, freeze-drying, silica-drying
C) Pickling - salting
D) Treatment with chemicals - alcohol, formalin, glycerin, etc.
E) Embedding - oils, waxes, plastics
F) Encapsulating - tars, resins, plastics

It is significant that of these six groups, *five* were, in one manner or another, included in mummification procedures followed by the Egyptians. Some of the properties which are needed for a preservation method to be acceptable are:

1) safe: non-flammable, non-explosive, non-toxic,
2) economical,
3) easy to handle.

Generally, the specimens treated in a preservative method must retain:

A) physical properties
  - a) structure - shape and size,
  - b) consistency - flexibility and strength,
  - c) appearance - colour and translucency,

B) chemical properties.

The purpose of any preservation method is to introduce some physical and/or chemical changes to stabilize the tissues, so their structure and composition are preserved in the most life-like state possible. To render desired results, the method used must: block autolitic enzymes, prevent shrinkage, swelling, distortions, dissolution, be bactericidal, light resistant, insoluble, non-flammable, non-toxic, etc. *In reality: the ideal method is a paradox.*

PERSPECTIVES OF THE PRESENT

It is becoming increasingly obvious how much we need to increase our knowledge of preservation. We can list a few reasons here:

Ecological: Not only do species vanish from the planet, but we actively contribute (in the name of education) to the destruction of millions of specimens for instructional purposes every year without consideration of the full ecological impact.

Economical: Enormous savings could be made by the development of inexpensive alternatives to the annual acquisition of deciduous plants, flowers, animals and even trees for instructional purposes.

Commercial: The potentials within the commercial sector are open-ended.

Educational: It is refreshing to know of scientists' concern for improvement in preservation methods. We can quote one of them: "The central problem in biology, in general, and museums, in particular, is a completely inadequate preservation technology." "The conservation of biological specimens through a preservation technology appropriate to 20th century needs is long overdue. It would be proper if museums helped to lead the way, because, while biology needs better specimens, museums are clearly being severely retarded by the present preservation methods" (Edwards 1979).

Scientific: Our present biological collections are completely inadequate to the inquiring scientific mind. Incomplete and distorted specimens form our present legacy.

STRATEGIES FOR THE FUTURE

Literally anyone can contribute to the development of the science of diatirology. For example, one may rigorously collect data related to the decay and deterioration of certain specimens while another may research market demands for preserved educational products.

For scientists willing to contribute without the element of great risk, it is advisable to proceed within the boundaries of a well established field, e.g., art conservation, histology or histochemistry. Other scientists, also willing to contribute without leaving the realms of their field of expertise, can offer their services in aid of specific diatirological projects, while, at the same time, they can help to build up the body of scientific knowledge of diatirology to benefit future work.

Another fine strategy is to work under one roof and share common interests with others, as is the case of all of us in this 1981 Workshop on Care and Maintenance of Natural History Collections. We consider it an honour to participate in this Workshop.

DISCUSSION

A word of caution ought to be spelled out to eager newcomers to the field of diatirology:

> *Warning:* Since sciences and technologies have progressed so fantastically in the last decades, a naïve approach (a necessary requirement to remedy the existing gap in knowledge of diatirology) by a young enthusiastic student who is willing to make a meaningful contribution to this field may unfortunately result in discrediting by peer colleagues and fellow scientists. He may well be tagged an empiricist.

Without any attempt to demonstrate to the many who believe that science has nothing to do with empirical work, let us simply state that sciences keep making daily progress through empirical work, i.e., experimentation where both success and failure can result. Empiricism can be interpreted in two ways: 1) it can be seen as a search for knowledge by observation and experimentation, and 2) it can be seen to rely on experience only, disregarding scientific methods altogether.

A young scientist may have great regard for all scientific disciplines; he may even be knowledgeable in many sciences and dream of cooperating with scientists in other fields. He may conscientiously request funds for equipment and salaries to accomplish great tasks. However, he must be aware that his performance can be criticized every step of the way by other members of the scientific community, who take delight in tagging him as an empiricist because he has "disregarded" available scientific knowledge in related scientific fields. If a young scientist is steadfast, tough, and fully confident, there is no need to worry.

ACKNOWLEDGEMENTS

The Biological Preservation Research Group of Queen's University has been fortunate in finding excellent support from many persons within and outside of the University. We would like to express our gratitude by listing their names here, but we consider it more appropriate to express our appreciation, admiration and respect - in silence, in the same special manner by which they helped us.

REFERENCE

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OSTEOLOGICAL PREPARATION TECHNIQUES USED BY THE ZOOARCHAEOLOGICAL IDENTIFICATION CENTRE

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CUMBAA, S.L. 1983. Osteological Preparation Techniques used by the Zooarchaeological Identification Centre. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 29-35.

ABSTRACT- The Zooarchaeological Identification Centre maintains a large comparative osteological collection of Canadian mammals, birds, reptiles, amphibians and fishes. About 3,000 prepared and catalogued skeletons are in the collection, which is used daily for a variety of archaeological and biological identification projects. Specimens range from completely or partially articulated to completely disarticulated preparations. Our preparation techniques are varied, but center on a "kitchen sink" approach, i.e., using simple procedures and common household cleansers with a conscious attempt to avoid toxic and flammable materials. Explained in detail are our procedures to clean skeletal materials by dermestid beetles, boiling, and maceration and to prepare and mount fish scales.

RESUME- Le Centre d'identification zooarchéologique possède une grande collection ostéologique de référence sur les mammifères, oiseaux, reptiles, amphibiens et poissons du Canada. Quelque 3 000 squelettes préparés et catalogués se trouvent dans la collection, à laquelle on a recours quotidiennement pour toutes sortes de projets d'identification archéologique et biologique. Les spécimens se trouvent dans différents états de préparation, qu'ils soient complètement ou partiellement articulés, ou entièrement désarticulés. Les techniques de préparation sont diverses, mais on a surtout recours à des méthodes courantes, c'est-à-dire fondées sur l'emploi de moyens simples et de détersifs de ménage, évitant le plus possible les matières toxiques ou inflammables. Les méthodes employées pour nettoyer les ossements: dermestes (insectes coléoptères), par bouillonnement et macération, ainsi que les méthodes pour préparer et monter des écailles de poissons, sont expliquées en détail.

INTRODUCTION

Some preparation techniques and arrangements of the comparative skeletal collection at the Zooarchaeological Identification Centre (ZIC) differ from those of many museum collections. Our skeletal specimens are part of a working collection, which is in daily use by staff and other persons trying to identify bones and other hard tissues from various archaeological and biological projects. The osteological reference collection, organized and maintained to aid identification and interpretation efforts, is first and foremost a biological collection. Consequently, the initial stages of preparation are similar to those at any museum; i.e., collection data are gathered, after which specimens are weighed, measured and catalogued. Although most differences between our collection and others relate to the way that bones are numbered, labelled and housed, other variations include final cleaning techniques.

Skeletal preparation at ZIC is consciously a "kitchen sink" approach, simple and basic for three reasons: 1) the methods are safe, involving no hazardous chemicals; 2) the methods are inexpensive, with minimal capital equipment or supply costs; and 3) most importantly, they work. Of primary concern is the question of usefulness - in what form (completely or partially articulated, completely disarticulated) will the specimen be of most use? Secondarily, how fast is the skeleton needed? Once these decisions have been reached, the appropriate skeletonizing technique is chosen. Three basic techniques are used; dermestid beetle cleaning, maceration, and boiling. Usually skeletons are prepared as if they were to be placed in the dermestid beetle colony - they are skinned, defleshed with knife, scalpel and scissors, and then air dried. The brains are also removed from medium and large mammals. Specimens prepared in this fashion are easily stored, and can be put into the beetle colony, boiled or even macerated if need be. Of course, if a specimen is to be boiled or macerated immediately, it does not go through the drying stage.

DERMESTID BEETLE TECHNIQUE

Cleaning with the action of dermestid beetles is a well-known skeletonizing technique which we consider to be superior to all others. It is not labor-intensive and provides the best degree of articulation with the least possible damage to bones. A significant body of literature exists on the subject, and the NMNS dermestid colonies are maintained by normal guidelines. Major objections to this technique are occasional problems with the containment of the beetles, the allergenic "bug dust" which they produce, and getting a skeleton through the bugs quickly when their population or appetites are on a down cycle. When bone specimens are needed quickly, the beetles are not necessarily reliable producers. The colonies depend on the right balance of temperature, humidity, ventilation and food supply to function properly. Although we are occasionally surprised by the speed with which a given specimen is finished by the beetles, their order of preference usually is as follows: birds, reptiles, amphibians, mammals and then finally fish. In a good colony, a skeleton the size of a duck can usually be finished in approximately a week. Weekly visits are made to the beetle colonies, but we believe that more frequent maintenance is desirable.

Dried specimens are placed on a bed of double-layered cheesecloth in individual cardboard trays which lie on expanded-mesh screening covering a cotton-batting bedding material. Boxes housing individual colonies are fibreglass-coated plywood with a ventilation hole covered by special fine-mesh screening. The lids are hinged with a rubber-like gasket material around the edges, and have locking clasps. A hinged interior lid of screen adds an additional safeguard. The individual colony boxes are contained within a metal room with double doors and its own environmental controls.

Care is taken to insure that parts of one animal do not hang over another carcass; this reduces the risk of inadvertent mixing of skeletal parts. Lightly folding the cheesecloth over the carcass encourages the beetles and aids in retaining moisture without inhibiting the movement of the beetles from one carcass to another. A varied diet within an individual colony and at least weekly light sprayings of water seem to help.

When retrieving specimens from the colony boxes, we wear disposable surgical masks to reduce the inhalation of "bug dust" which has been known to create allergenic respiratory responses.

Carcass parts are either picked out individually or the entire cheesecloth "package" is carefully lifted from the cardboard tray and placed in a plastic bag, complete with labels. Specimens are then placed in a freezer for at least a week or two to kill off any bug activity, after which they are retrieved and carefully cleaned. Spraying with water as soon as the specimen comes out of the bag helps keep down dust. The bones are then rinsed off under the tap in a screen and put in a moderately hot water and ammonia (about 10%) solution to soak and degrease. We use powdered Amex to mix our solutions. This ammonia solution is changed daily until it remains clear. If specimens are especially delicate or the articulation itself is fragile, the bones are put onto window screen trays with wire handles. Specimens can then be dipped in and out of solutions and rinsed with minimal disturbance. After the ammonia bath, bones are thoroughly rinsed in water and laid out on tabletops on screen trays to dry slowly. A layer of damp cheesecloth laid over the bones reduces the rate of evaporation and prevents cracks which sometimes occur in long bones of larger mammals. If the cheesecloth which comes out of the bug colony is in good shape, it is washed in detergent, rinsed, dried and used again.

MACERATION TECHNIQUE

Maceration is another skeletonizing technique used at ZIC. Our maceration technique is not refined to the same degree as, for example, that of Jack DuBois at the Museum of Man and Nature, Winnipeg, Manitoba, who uses controlled heat and enzymes to produce excellent results. His facility is capable of handling very large animals, while ours is limited to what can be put into containers of about 22 litres capacity. For the most part, we restrict our specimens to 4.54 litre (1 gal) screw-top wide-mouth jars which are obtained as discards from restaurants. Specimens can be easily observed without opening the lids of glass containers. For us, maceration offers a big advantage: it is the least labor-intensive procedure with little possible damage to bones. The skeletons of fish can be produced very quickly with this technique, but some mammals, birds, and herps take considerably more time (two, three or more weeks). Major disadvantages are: the pervasive smell when pouring off the supernatant, the degree of control of articulation, and to some extent, time. The major disadvantge to enzyme use is that specimens can be literally eaten up if not closely watched. The bones of small birds and rodents are particularly vulnerable.

Our process is extremely simple. We put the specimen in a container of the appropriate size, fill the container with water at 30-40°C leaving some room at the top, put the lid on with catalogue number or data tag affixed to the jar, and place it in an enclosure next to a warm pipe that runs between two radiators. The heat aids enormously in the enzymatic action. When the heat for the building is off, maceration slows down considerably; sometimes the heat from light bulbs is used to advantage. In the past we have used Bio-Ad detergent (an enzyme product) to speed things up, but it did not suit our set-up and required too much attention. We have been able to control the degree of disarticulation of specimens by keeping careful watch on the jars. Our rule of thumb is: the more time a specimen macerates, the less cleaning is required to prepare it for the collection. A specimen goes through several rinses and is put in the ammonia and water bath for final degreasing. The ammonia helps to dissolve stubborn cartilage and soften any remaining soft tissues which can be removed by brushing or rinsing. Pine oil or liquid dishwashing detergent are sometimes added to very smelly or greasy specimens.

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

BOILING TECHNIQUE

Boiling is not used very often but it is very useful if there is an urgent need to produce a skeleton. Very good results can be obtained if the pot is checked frequently, if specimens do not boil too long and if sufficient time is available to let the water cool down before rinsing in cooler water. This method is best for adult bird and mammal specimens. Fish specimens should not be boiled unless absolutely necessary, and then only simmered in water. Young birds, mammals and herps are much more susceptible to damage from this technique than from the others described.

Pots for boiling should be large enough to easily accommodate the specimen with at least a few inches of "boiling room" to avoid spill-over. Heavy-gauge aluminum pots are used on a heavy-duty hot plate with a smooth cast-iron top plate. Our equipment brings a 68-litre pot to a full boil in 1-1½ hours. A pot of this size is sufficient to boil an entire sheep or coyote, but obviously a cow or bison takes two or three pots. Specimens are kept at a low boil; nothing is boiled longer than 3-3½ hours. Best results are obtained when specimens are left in the pot overnight to cool down, then cleaned up within the next day or so. Sitting for up to 48 hours in solution makes specimens easier to clean. Most birds and turtles require two hours, but fish should be simmered for only 30-45 minutes. Higher heat, increased time or additives usually warp or "blister" fish bones. Specimens previously preserved in alcohol may require additional time.

For the most part we use water without additives, but very greasy specimens sometimes require a cup of ammonia powder at the time the heat is turned off. Before boiling the long bones of large mammals are drilled proximally and distally on the shaft, away from articular surfaces or diagnostic muscle scars to facilitate marrow and grease removal. For the final cleaning process, a rectal syringe is useful to blow out material from inside long bones. Individual limbs to be boiled or macerated are "bagged" in window screen or cheesecloth pouches. When these limb specimens are kept separated during the cleaning, drying and labelling procedures, the small carpals and tarsals are easier to sort out.

FINAL CLEANING AND PREPARATION

Final cleaning is virtually the same with all our cleaning techniques. This final cleaning involves the removal of all the remaining soft tissue by hand, scalpel or brush followed by soaking in 10% hot ammonia as long as necessary, rinsing in clear water, and finally slow drying. Slight variations include scrubbing greasy large mammal bones with dishwashing detergent and water, and perhaps bleaching darkly stained bones in 5% hydrogen peroxide for a few miniutes to an hour before final rinsing. Excessively white bones may look attractive but they are difficult to use effectively in identification work, since muscle scars, pits and minor morphological features no longer stand out visually.

For final preparation, every bone that is large enough has a catalogue number written on it with indelible ink. This avoids mix-ups when comparing large series of skeletons. Skeletons are not fit into the smallest box which will hold them, but are placed in an organized fashion in clear plastic boxes or in cardboard boxes with clear acetate lids. Most bones are labelled "R" (right) or "L" (left), and usually at least one skeleton in each family in all classes has all the bones, including carpals and tarsals, properly identified. Although time consuming at the outset, this saves a great deal of time when using these specimens repeatedly for identifications.

SPECIAL COLLECTIONS

We have a "type" collection of major elements from all bird orders, plus more specialized collections of elements of ducks and grouse/ptarmigan for quick reference. This may be expanded to include fish in the future, but for now our fish special collections include only otoliths and scales. The scales are mounted in labelled 2 x 2 glass photographic slides in slide binders which are held in several looseleaf notebooks. They are in taxonomic order, and thus provide a quick reference for gross morphology and scale type; individual slides can be easily removed for viewing under the microscope or for projection on a screen. This easy technique of mounting slides was developed by Brad Parker while working in the Ichthyology Section of the Museum. Scales are selected from all body regions, relaxed in warm dishwashing detergent solution, rinsed in water, and put in hot ammonia to degrease for a few minutes; any remaining skin is brushed off with a toothbrush. Finally the scales are rinsed in water, patted dry with paper toweling, and mounted between standard microscope cover glasses in glass slide binders. The entire process takes just a few minutes, and the cost is about 25 cents per slide.

DISCUSSION

Our expertise in skeletal preparation has been accumulated over nine years with a bit over 3,000 skeletons. No claims are being made for the "best method" or for any original ideas. We have developed a repertoire of techniques which are low cost, safe, and effective. We are continuing to experiment. The key to a good preparation is to decide at the beginning the best use of the particular specimen, paying attention to time limitations. Once the decision has been reached, careful work and attention to final preparational details are the main criteria involved in producing a valuable skeleton; the specific technique used is not so important.

THE PREPARATION OF LEECH SPECIMENS: RELAXATION, THE KEY TO PRESERVATION

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MADILL, J. 1983. The preparation of leech specimens: relaxation, the key to preservation. In: Proc. of 1981 Workshop on the Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 37-41.

ABSTRACT- A technique is described for the preparation of specimens of leeches (Annelida: Hirudinea). Narcotizing agents for live leeches are discussed. Detailed steps showing how to narcotize, fix and preserve leeches are given.

RESUME- La communication décrit une technique de préparation de spécimens de sangsues (Annélides: Hirudinées). On y examine l'action d'anesthésiques sur les sangsues vivantes et on décrit de façon détaillée les étapes de l'anesthésie, de la fixation et de la conservation des sangsues.

INTRODUCTION

The scientific value of biological specimens can be increased by paying careful attention to their preparation. Bones and shells help to maintain the form and shape of many animals. But what must be done with animals which have no skeletons? It is difficult to examine specimens in the form of an unrecognizable blob or a complicated knot, positions readily assumed by soft-bodied animals dropped directly into a jar of preservative.

NARCOTIZING AGENTS

Many narcotizing agents are available. Some of the earliest investigators used weak acids such as tea, lactic acid, chromic acid, weak hydrochloric acid and lemon juice. Death occurs in a relaxed state. Magnesium salts, chlorotone, chloroform and ether (Zinn and Kneeland 1964) kill the leech in a relaxed state caused by "paralysis of the respiratory centre" (Gee 1913). Unfortunately, "excessive relaxation in chloroform, chlorotone, or magnesium chloride causes the furrows between the annuli to disappear" (Elliott and Mann 1979). Drugs such as strychnine, cocaine, nicotine, and menthol crystals cause either muscular stimulation or paralysis depending on the dosage used (Gee 1913). It is difficult to achieve the desirable state of relaxation or to revive narcotized specimens when using any of the above mentioned chemicals, therefore their use is not recommended.

Heating water containing leeches to 40°C causes death by asphixiation (lack of oxygen) in an extended position, or placing the leeches in a freezer kills most of them in an undistorted position (Sélensky 1915, McClung MS. 1974). These methods are rarely used because the specimens can not be revived and the methods are not easily applied in the field.

The two most widely accepted leech narcotics are carbon dioxide and ethyl alcohol (Davies 1971, Elliott and Mann 1979, Klemm 1982). Both carbon dioxide and ethyl alcohol cause temporary anaesthesia. This is useful both when close examination of live specimens is desired, and to relax the specimens for fixation. The leeches recover when returned to fresh water. Carbon dioxide, in the form of a pure gas is a quick-acting narcotizing agent, and relaxation occurs within five minutes. Ethyl alcohol takes about ten minutes. It is effective in small quantities and is easier to transport to the field. Ethyl alcohol is added slowly so that the degree of relaxation can be accurately controlled.

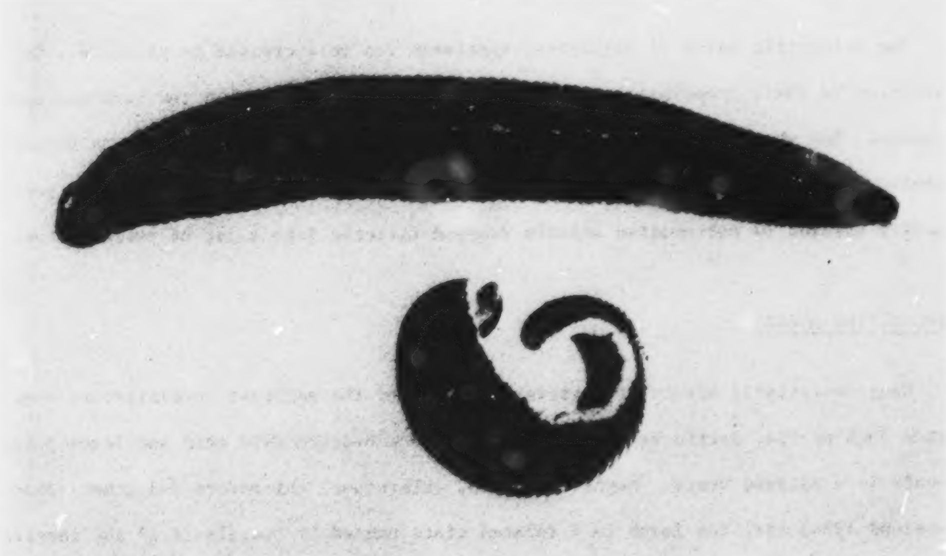

FIGURE 1: *Photograph of* Macrobdella decora *(Say, 1824) from the Ottawa area (National Museums Canada Invertebrate Catalogue Nos. 1981-518 and 1981-519). The upper specimen (8.2 cm) has been relaxed by adding the narcotic ethyl alcohol drop-by-drop and preserved in 75% ethyl alcohol. The lower specimen (92.5 cm) has been placed directly into the preservative, 75% ethyl alcohol.*

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

TECHNIQUE FOR PREPARING LEECH SPECIMENS

The ideal is to preserve specimens in as natural a state as possible. Using my work with leeches as an example, a properly prepared leech is positioned much as it would be at rest, extended and straight. This means that a specimen is relaxed, but not excessively, so that the segmentation and markings are impossible to resolve. Annuli and papillae are used to locate the genital pores, sense organs and other structures. An excessively contracted specimen is worse. Leeches tend to curl up when dropped directly into fixative. Rolled up specimens have obscure anal, oral, and genital openings. Relaxation can be achieved with the use of narcotizing agents. Figures 1 and 2 show the difference between relaxed and contracted specimens of *Macrobdella decora* and *Placobdella ornata* using ethyl alcohol as the narcotic.

During the course of my study, I have found the following method most satisfactory for narcotizing, fixing, and preserving leeches.

1) Put the leech in a petri dish cover (100 mm x 15 mm) and add just enough water to cover the animal.

2) (Optional) Place the petri dish bottom on top of the leech, if the leech crawls out of the dish or curls up. Do not apply pressure to flatten the specimen.

3) Add 95% ethyl alcohol to the water a few drops at a time. Continue adding alcohol until the leech stops moving. The leech contracts at first but within a few minutes begins to relax as the dosage of alcohol increases. An overdose of alcohol may cause strong muscle contraction, but if this happens, fresh water can be added to revive the leech. Leeches should be narcotized one at a time because their tolerance to alcohol varies and also the copious amount of mucous produced by several leeches tends to neutralize the effect of the narcotic. In this manner, the rate of relaxation can be optimally controlled.

4) When the leeches are limp and no longer respond to touch, dirt and excess mucous are removed on a paper towel.

5) The leeches are then fixed for 24 hours in 5% formalin. Curling at this time may be prevented by the weight of the petri dish bottom. Other fixatives, such as Fleming's and Bouin's solutions, should be used for histological preparations.

6) The fixed specimens may be preserved in either 75-85% ethyl alcohol or 5% formalin.

Formalin preserves the colour longer but ethyl alcohol is recommended since it is safer to use and less destructive to soft tissues. For long term storage the specimens should occupy no more than 40% of the total volume of the fluid in the container.

Techniques for the preparation of museum specimens of leeches are easy to learn and simple to practice. Specimens may be kept in excellent condition as a result of proper methods of relaxation, fixation, preservation, and storage. A properly relaxed specimen has greater scientific value since it can readily be identified, dissected or sectioned.

ACKNOWLEDGEMENTS

I appreciate the assistance of several of my colleagues in the preparation of this manuscript.

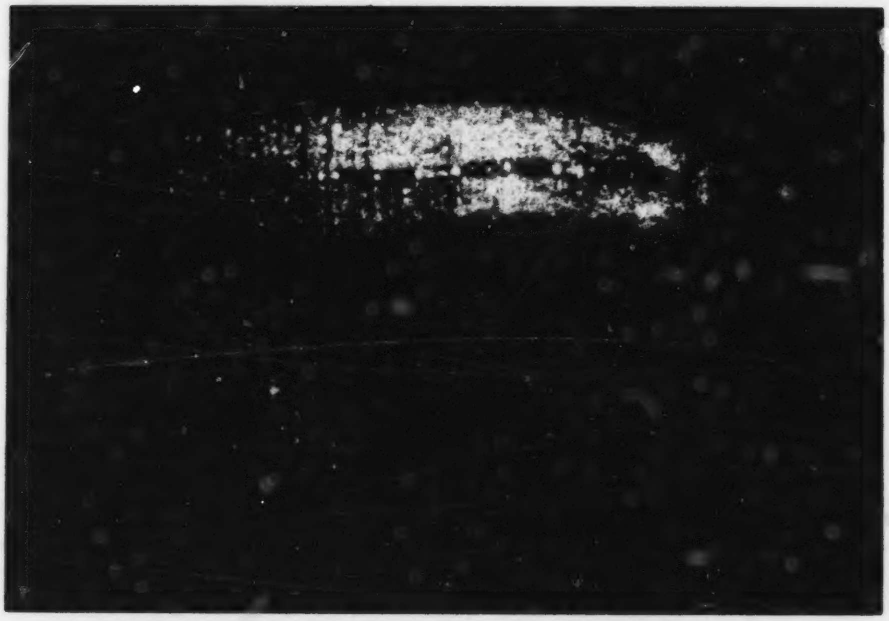

FIGURE 2. *Photograph of* Placobdella ornata *(Verrill, 1872) from the Ottawa area (National Museums Canada Invertebrate Catalogue No. 1981-521). The upper specimen (3.4 cm) has been relaxed by adding the narcotic ethyl alcohol drop-by-drop and preserved in 75% ethyl alcohol. The lower specimen (1.5 cm) has been placed directly into the preservative, 75% ethyl alcohol*

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VAPOUR DEGREASING. A NEW TECHNIQUE FOR DEGREASING AND CLEANING ENTOMOLOGICAL SPECIMENS

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McKILLOP, W.B. and W.B. PRESTON 1983. Vapour degreasing. A new technique for degreasing and cleaning entomological specimens. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 43.

ABSTRACT- (McKillop, W.B. and W.B. Preston, 1981. Vapour degreasing. A new technique for degreasing and cleaning entomological specimens. CAN. ENT. 113: 251-253, 6 figures, abstract, no résumé). Vapour degreasing and cleaning of entomological specimens proved to be a viable alterntive to standard methods. Defined change in colour upon degreasing clearly portrayed the effectiveness of this new technique.

RESUME- (McKillop, W.B. et W.B. Preston, 1981. Vapour degreasing. A new technique for degreasing and cleaning entomological specimens. CAN. ENT. 113: 251-253, 6 figures, abstract, sans résumé). La technique qui consiste à nettoyer et à dégraisser à la vapeur des spécimens entomologiques s'est avérée une méthode valable qui s'ajoute à celles déjà utilisées. Le changement de couleur visible après le dégraissage montre nettement l'efficacité de cette nouvelle technique.

A TECHNIQUE FOR THE PREPARATION OF SPECIMENS OF THE MENINGES OF THE BRAIN[1]

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ROMERO-SIERRA, C.J. DRISCOLL, W. LYONS and P. LANE 1983. A technique for the preparation of specimens of the meninges of the brain. In: Proc. of 1981 Workshop on the Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 45-48.

ABSTRACT- A technique to prepare specimens of the meninges of the brain is presented. It consists of removing brain and meninges intact from the skull of a fresh or embalmed skull. The brain is pithed and removed and the meninges are freeze-dried and coated with urethane. The result is a stiff specimen that demonstrates the important macroscopic characteristics of the meninges.

RESUME- La communication présente une technique pour préparer des spécimens de méninges. Elle consiste à retirer intacts le cerveau et les méninges d'un crâne frais ou embaumé. Le cerveau est extrait, et les méninges sont lyophilisées et enduites d'uréthane. Cette méthode donne un spécimen rigide qui permet de voir les importantes caractéristiques macroscopiques des méninges.

INTRODUCTION

Traditionally, the meninges of the brain have largely been studied from textbooks and charts. No technique of preserving them as separate specimens has been discovered in literature searches. In recognition of this deficit, and with the intention to aid students in understanding the actual configuration of the meninges, formation of sinuses, etc., the following described technique was developed. Although this technique was developed for the meninges of the human skull, it is equally suitable for smaller mammalian skulls and possibly other vertebrate skulls.

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[1] This paper constitutes one part of the keynote address given by Dr. Romero-Sierra at the Workshop. Other parts include: "The potentials of diatirology", "An overview of formalin techniques for the fixation of cadavera", "Techniques for the preparation of whole brain specimens", and "Preservation of biological specimens by freeze-drying techniques".

PREPARING INTACT SPECIMENS OF THE MENINGES OF THE BRAIN

After the jugular veins of a fresh or embalmed cadaver had been injected with latex, and it had set for 24 hours, the scalp was retracted. A ½ in hole was drilled in the calvarium at the sagittal suture, midway between bregma and lambda (Fig. 1). Care was taken that the dura was not perforated during this procedure. From this hole, two series of cuts were made with an autopsy saw, i.e., one series of twelve radial cuts and one series of three or four concentric cuts at intervals of 2-4 cm (Fig. 1). Again, care was taken to avoid perforating the dura. The skull was thus broken up into manageable parts that could be removed with the aid of a chisel. With the skull cut in this manner, the rest of the dura could easily be separated from the base of the skull. This was done bilaterally, using both hands simultaneously. The brain stem was sectioned at the level of the medulla, and the specimen removed *in toto*. Using first a probe and then a kitchen knife and other blunt objects, the brain substance was totally pithed and washed away from the dura. This cavity was carefully filled with cotton waste, so that the falces, tentorium and other internal characteristics of the specimen remained intact and in place. Subsequently, the specimen was frozen and freeze-dried for 3-4 days.

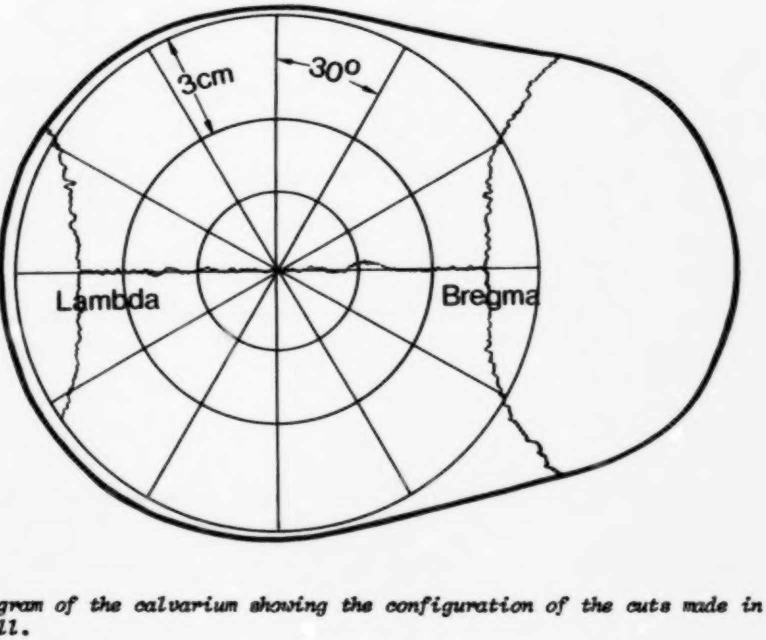

FIGURE 1: *Diagram of the calvarium showing the configuration of the cuts made in the skull.*

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

After the freeze-drying procedure was completed, the cotton waste was carefully removed from the now brittle specimen. A 5 cm square "window" was then cut in the frontal aspect of the specimen (Fig. 2), and urethane brushed over inner and outer surfaces of the meninges. To achieve a durable specimen, it was necessary to completely coat the specimen three or four times.

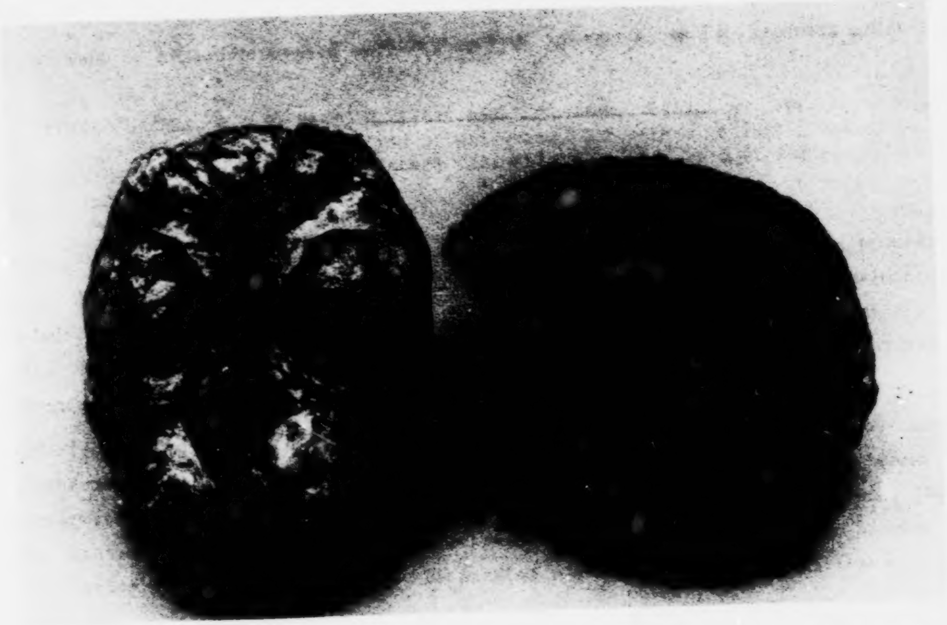

FIGURE 2. *Inferior (left) and lateral (right) views of finished specimens of the meninges of the brain.*

DISCUSSION

Basically this technique consists of obtaining a vertebrate brain specimen with intact meninges, replacing the brain substance with cotton packing and freeze-drying the meninges. After the cotton has been removed and the specimen coated with urethane, a good specimen showing the morphological characteristics of the meninges is achieved.

Because of the delicate nature of the specimen, a number of the stages in the procedure proved troublesome. In particular, drilling through the skull resulted, in a few cases, in minor perforations of the superior sagittal sinus. Also, extreme care had to be taken in cutting the skull with the autopsy saw. When pithing the brain matter, very blunt objects had to be used, and subsequently, the cotton waste was put in place very carefully and then even more carefully removed from the specimen. Finally, once a good, hard specimen had been obtained, it was still quite fragile and would not stand up to rough handling. It has proven an invaluable teaching aid and a popular museum specimen.

PREPARATION OF SPECIMENS / PREPARATION DES SPECIMENS

AN OVERVIEW OF FORMALIN TECHNIQUES FOR THE FIXATION OF CADAVERA[1]

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ROMERO-SIERRA, C., P. LANE, W. LYONS and J.C. WEBB. 1983. An overview of formalin techniques for the fixation of cadavera. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 49-52.

ABSTRACT- To clarify and remove some of the mystique surrounding embalming procedures, a brief description of the basic technique is presented with three common embalming and preserving formulae. A discussion of the rationale behind the use of some of the agents and a brief description of the results are included. Both positive and negative aspects of the procedure are discussed.

RESUME- Dans le dessein d'élucider et de dissiper en partie la mystique entourant l'embaumement, cette communication présente trois procédés courants d'embaumement et de conservation ainsi qu'une brève description de la technique de base elle-même. Suit un examen des raisons qui justifient l'usage de certains des agents de conservation de même qu'une brève description des résultats obtenus. On examine ensuite les aspects positifs et négatifs de la technique.

INTRODUCTION

Robert Boyles' discovery in 1663 of the preservative properties of spirit heralded the onset of the practice of fixing cadavera for use as anatomical specimens. The discovery of formic acid two hundred years later led to the use of formaldehyde as the principal agent in embalming procedures. Glycerin and phenol were subsequently added because of their respective properties as a humectant and a bacterial agent. These three ingredients, in addition to alcohol, have formed the basic formula for embalming in universities throughout the world for many years.

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[1] This paper constitutes one part of the keynote address given by Dr. Romero-Sierra at the Workshop. Other parts include: "The potentials of diatirology", "A technique for the preparation of specimens of the meninges of the brain", "Techniques for the preparation of whole brain specimens", and "Preservation of biological specimens by freeze-drying techniques".

Unfortunately, little research has been devoted to developing new and improved techniques for the preparation of cadavera. Instead, methodologies have evolved slowly. Often accomplishments have been lost and forgotten altogether, when improvements have not been adequately documented by those who have contributed in their practical work to the knowledge in this area. This paper is a brief account of formalin fixation techniques used in university departments. An attempt is made to explain the rationale for some of the differences.

A TECHNIQUE FOR THE FIXATION OF CADAVERA

For injection of the embalming fluid, the cadaver is laid on its back on a post-morten table with supports under the neck and lumbar spine to prevent uneven fixation in the buttocks and shoulder region. Usually the common carotid and femoral arteries are dissected out bilaterally and one jugular vein is exposed. Arteries are then cannulated and the vascular system flushed. This is done with either an arterial conditioner or, more commonly, the embalming fluid without the formalin (Table 1). When throughly flushed of blood, the arteries are injected with the embalming fluid at 5-15 psi, pulsating pressure. Injection is continued until the colour of the tissues fades and muscles become "stiffer". Incompletely fixed areas can be later injected with the fluid through a hypodermic needle. At this point, many methods call for the injection of coloured latex to make the vessels more visible. Latex requires 24-28 hours to set within the vessels.

Once the injection procedure is completed, the hands, feet and sometimes the head are wrapped in cotton waste soaked in the preservative fluid. The cadaver is then covered with plastic bags and stored in an appropriate container. Once the skin has been removed from a region of the cadaver for dissection, the exposed area must be carefully covered with cotton waste or towelling soaked in preserving fluid to prevent drying and oxidation.

TABLE 1: THREE FORMULAE[a] FOR EMBALMING AND PRESERVING SOLUTIONS USED FOR HUMAN CADAVERA

	Formula A[b]		Formula B		Formula C	
	Agent	% by Volume	Agent	% by Volume	Agent	% by Volume
Embalming Solutions	Glycerin	22	Glycerin	15	Glycerin	8
	Formalin	5	Formalin	2.5	Formalin	2
	Phenol	5	Phenol	3	Phenol	7
	KAc	3 (dry)	KAc	3 (dry)	Water	50
	Dettol	5	Dettol	3	Ethanol	33
	Ethanol	60	Ethanol	73.5		
Preserving Solutions	Glycerin	10	Glycerin	7	Glycerin	5
	KAc	3 (dry)	KAc	3 (dry)	Formalin	1
	Dettol	5	Dettol	3	NaCl	1 (dry)
	Water	82	Water	87	Water	93

a. *These formulae were solicited from several anatomy departments from universities in both Canada and the United States.*

b. *For an especially obese cadaver an extra 1% (volume) of Dettol and formalin is added.*

DISCUSSION

These embalming techniques are difficult to rationalize, since they have been handed down from one morgue attendant to the next by word of mouth. Very little has been carefully thought out or set to paper. As an example, Table 1 lists three common but different preserving and embalming fluids. Basically, the formaldehyde prevents the auto-digestion of protein by its own action as a non-coagulant additive; it fixes actinmyosin linkages and some lipids. Phenol is used because it is a potent bactericidal and fungicidal agent. Glycerin, owing to its hygroscopic character, is a good humectant. Ethanol acts as a non-additive coagulant with a moderate rate of penetration. Potassium acetate (KAc) is used in hopes of retaining some natural colour in the tissue. The proportions of ingredients vary greatly from place to place, depending on environmental factors and personal methods of dissection. For instance, in a dry heated dissecting room during a Canadian winter, more glycerin and less ethanol are used than in a hot humi dissection room in a warmer country.

Although the "tried and true" formalin fixation technique has proven itself to be more than adequate at preserving tissues and preventing decay and growth of bacteria and mold, it has drawbacks and shortcomings that must be noted. Formaldehyde fixes the actin-myosin linkages that form after death in the absence of A.T.P. The results are distorted muscles which are often difficult to identify and orient. Also, the fixative properties of formalin and ethanol together make most joints inflexible. The colours of tissues become totally unnatural. Formalin, glycerin and phenol all oxidize upon exposure to air and turn tissues brown or black. This is initially prevented by the bleaching quality of the ethanol, but since it is non-additive, it quickly evaporates. Perhaps the most undesirable qualities of this technique are the direct effect of the ingredients on the dissector/student. These chemicals, especially the formaldehyde and phenol, are irritating to the skin and one individual in ten is particularly sensitive. These agents also give off very offensive odours, which can cause real damage to conjunctivae and nasal mucosa.

In the past, an aqueous 10% formalin solution was the main fixative used. The drawbacks described above were so intense with the use of this concentration that persistent but unsuccessful attempts have been made to lower the strength of the solution without rendering it ineffective. In some of these attempts, the concentration of formalin was reduced and other chemicals added to retain the preservative power of the fluid, while at the same time minimizing the formalin drawbacks. Considering all facts, the formulae listed in Table 1 are far superior to simple aqueous formalin solutions, although none is ideal. These fluids have been in use for a long time and have proven to be more than adequate for preservative techniques. However, certain drawbacks, which have been recognized and tolerated for years, must be reckoned with some day. Perhaps the preparation of whole anatomical specimens requires more than simply the preservation of tissues!

TECHNIQUES FOR THE PREPARATION OF WHOLE BRAIN SPECIMENS[1]

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ROMERO-SIERRA, C., W. LYONS, J. DRISCOLL, P. LANE and J.C. WEBB. 1983. Techniques for the preparation of whole brain specimens. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 53-56.

ABSTRACT- Two techniques are presented for freeze-drying and subsequent treatment of whole-brain specimens. The first technique involves coating the specimen with urethane and results in a glossy specimen, well suited as a teaching aid or museum specimen. The second technique involves coating in the freeze-dried specimen with Microfil® and results in a dull and flexible specimen, well suited for individual study by students. In both cases the brains are well preserved and show the morphology in good detail, while eliminating the unpleasant characteristics of material fixed in formalin.

RESUME- La communication présente deux techniques de lyophilisation et de traitement ultérieur du cerveau entier. Dans la première technique, le spécimen est enduit d'uréthane, ce qui le rend lustré, prêt à être utilisé comme outil pédagogique ou spécimen de musée. Dans la seconde, le spécimen lyophilisé est revêtu de Microfil®, ce qui le rend mat et souple, approprié à l'examen individuel. Dans ce cas, le cerveau bien conservé permet d'observer les moindres détails de sa morphologie, tout en évitant les inconvénients que comporte la fixation de spécimens dans le formol.

INTRODUCTION

As a result of our dissatisfaction with conventional formalin fixing techniques, a series of experiments was conducted to develop new techniques for the preparation of whole-brain specimens. Primary aims of these experiments were to produce specimens that: 1) could be comfortably handled with bare hands, 2) did not smell unpleasantly, 3) did not irritate nose or eyes, 4) were well preserved, and 5) accurately represented the morphological structures. This account presents the two best techniques resulting from these experiments. Both techniques involved freeze-drying of formalin fixed brains first. The first procedure, coating the specimen with urethane, produced a rigid, shiny specimen. The second procedure, treating the specimen with glycerin and Microfil®, produced a soft, flexible specimen.

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[1] This paper constitutes one part of the keynote address given by Dr. Romero-Sierra at the Workshop. Other parts include: "The potentials of diatirology", "A technique for the preparation of specimens of the meninges of the brain", "An overview of formalin techniques for the fixation of cadavers", and "Preservation of biological specimens by freeze-drying techniques".

Although these techniques were developed for the human brain, they would certainly prove useful for the preservation of a wide variety of other animal organs or tissues.

GENERAL PREPARATION AND FREEZE-DRYING

Formalin-fixed brains with all the important gross anatomical structures (e.g., all cranial nerves, representative gyri, and cortices) firm and intact were selected. First these brains were cleaned of all vessels and meninges and set under cold running water for 8-10 hours to remove blood pigment and residual formalin. Each specimen was then set upside down on loose cotton or cloth in the bottom of an open, shallow box. The brain stem was supported and cranial nerves were pinned and wrapped so that all anatomical relationships would be correctly preserved. The boxed brain was then placed in a freezer where it was frozen. The box was then transferred to a freeze-dryer where it was retained for ten days to two weeks. The specimen was weighed daily and it was removed from the freeze-dryer when the weight stabilized. The specimen was then taken out of the box and all cotton, cloth, and pins removed. As mentioned in the Introduction, two alternate procedures were followed at this point.

URETHANE DIPPING TECHNIQUE

The brain was dipped in urethane and allowed to air-dry. This was repeated three to five times as required and extra urethane was brushed onto finer structures (i.e., cranial nerves, chiasma, etc.) to strengthen them. After each coating the urethane was allowed to dry completely and harden.

The urethane-coated specimens were glossy and brittle and care had to be taken to handle them. Finer structures broke when specimens were dropped. This rigidity, though, allows for a clearer visualization than is possible with formalin-fixed brains.

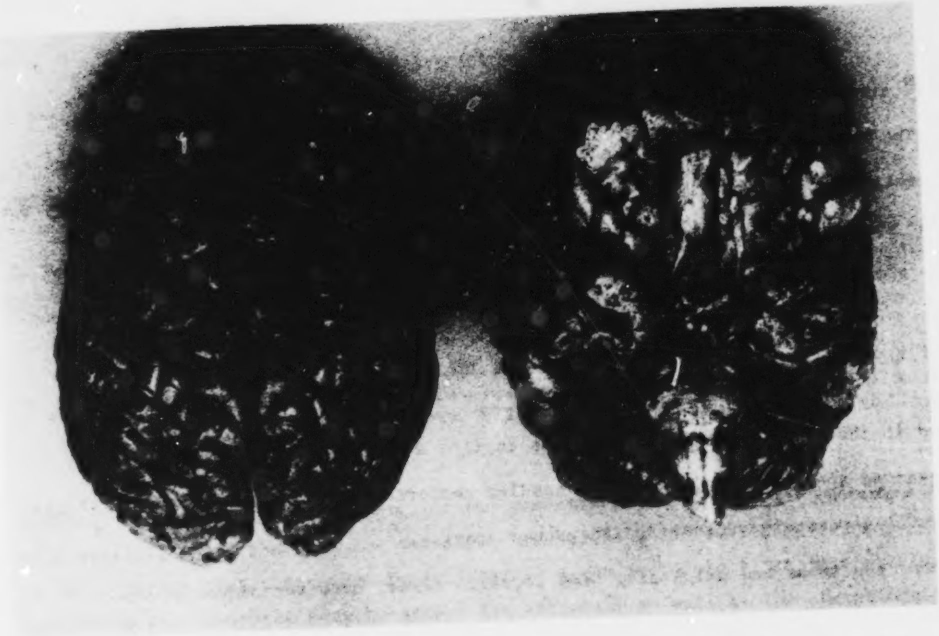

FIGURE 1: *Superior (left) and inferior (right) aspects of brain specimens prepared with the urethane dipping technique.*

GLYCERIN AND MICROFIL® SOAKING TECHNIQUE

In this second method, the freeze-dried brain was soaked in a solution of 10% glycerin in water. The solution was carefully worked into the grooves, fissures and sulci in order to fully saturate the specimen. After about 15 minutes, additional glycerin was added to make a 25% solution and this too was worked into the specimen. After an additional 15 minutes, the specimen was removed, covered loosely with cheesecloth and allowed to air-dry overnight. The following day, the specimen was coated with Microfil® (30 ml MV-dilutent; 24 ml MV-132 clear Microfil®; 1.06 ml catalyst)[2] by manually massaging it into the tissue. The tissue was then suspended to gel for 24-36 hours.

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[2] These three substances are available in a kit from Canton Biomedical Products, Boulder, Colorado, U.S.A.

Microfil® treated specimens were obviously different from urethane dipped specimens. The surfaces were dull and the entire specimen was more flexible and durable. Further dissection was possible with these specimens, although cut surfaces tended to dry out and discolour when exposed to air for any length of time. Furthermore, the distinction between grey and white matter was not as clear as with formalin-fixed specimens.

DISCUSSION

As stated in the Introduction, our goal was to find a method of preparation which produced preserved specimens which could be handled comfortably, did not have any irritating odour, and still accurately represented the structures.

Since these specimens had originally been formalin-fixed, both techniques produced specimens that were slightly discoloured due to the oxidation of formaldehyde. However, both techniques produced odourless specimens that could be comfortably handled - the all too familiar problems of formaldehyde had been eliminated. Our experience shows that glycerin and Microfil® coated specimens were better suited to individual study by students, whereas the urethane treated specimens were better suited as laboratory demonstration material and museum specimens.

PRESERVATION OF BIOLOGICAL SPECIMENS BY FREEZE-DRYING TECHNIQUES[1]

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ROMERO-SIERRA, C., J.C. WEBB, P. LANE and W. LYONS. 1983. Preservation of biological specimens by freeze-drying techniques. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 57-63.

ABSTRACT- Freeze-drying techniques for the preservation of biological specimens have been well established in the past few decades. However, a major defect of freeze-dried specimens is the rigidity that these techniques impart. A new methodology has been developed and the procedures are presented step-by-step. The rationale as well as the educational and economic value of the process is discussed.

RESUME- Les techniques de lyophilisation pour la conservation de spécimens biologiques sont d'un emploi éprouvé depuis quelques dizaines d'années. Toutefois, la rigidité des spécimens lyophilisés constitue le grave défaut de ces techniques. La communication présente une description étape par étape d'une nouvelle méthodologie, avec les raisons de son utilisation et des renseignements sur sa valeur éducative et économique.

INTRODUCTION

In recent years efforts have focused on the development of freeze-drying techiques for teaching purposes in museums and schools with hopes of developing better techniques than currently in use (Meryman, 1960; Harris, 1964; Hower, 1970). We carried out preliminary experiments with samples of various body tissues and a series of procedures for the preparation of whole specimens was designed and tested. The success of freeze-drying techniques led us towards an inspiring field of research. Rats, cats, frogs, birds, snakes and various marine invertebrates were tested with the dual objective of: a) finding the ideal

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1. This paper constitutes one part of the keynote address given by Dr. Romero-Sierra at the Workshop. Other parts include: "The potentials of diatirology", "A technique for the preparation of specimens of the meninges of the brain", "An overview of formalin techniques for the fixation of cadavers", and "Techniques for the preparation of whole brain specimens".
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method of preserving each animal specimen, and b) producing data to be later used to design various combinational methods.

MATERIALS

The most important piece of equipment required is a freeze-dryer[3]. Other pieces of equipment needed were: an upright freezer, a stainless steel vat, peristaltic pumps, a dissecting table, sinks with pipes and faucets, and a power drill. Also various chemicals and standard laboratory equipment were required.

PREPARATION PROCEDURES FOR A CAT SPECIMEN

As an exemplary case, the following describes step-by-step procedures for the preparation of a cat specimen. Procedures for mammal specimens larger or smaller than a cat can be interpolated accordingly. Porcupines, marmots, ground squirrels, mice, etc., can be prepared in the same fashion. A live cat specimen is first injected with a near fatal dose of Nembutal (25 mg/kg body weight) intraperitoneally to keep it for several minutes in an initial state of unconsciousness. While the cat is still alive and its blood continuing to circulate, but totally unfeeling, it is given an intravenous perfusion or anticoagulant (heparin) and vasodilator (histamine). If by the time the perfusion is completed, the first Nembutal injection has not yet brought about death by cardiac arrest, a second injection of Nembutal is administered. This procedure prevents suffering and prevents blood clotting. It also facilitates the exsanguination of the cat, which is subsequently carried out from the cat's body by the pulsating pressure at 2 lbs of a flushing solution (1 ounce of EPIC® drainage chemical per quart of water)[4].

Injections of red latex into the arterial system and blue latex into the venous system enhance the vessels. The latex is dissolved in equal parts of 2.5 M potassium acetate. This mixture is placed in a vacuum bottle, subjected to 2 lbs pressure with a compressor-canister, from which it is injected into the specimen. Specimens are then left for four hours to gel the latex. Similar latex injections may be carried out to emphasize lymphatic, renal or hepatic systems, if desired.

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[3] The freeze-dryer at Queen's University was manufactured at the Division of Mechanical Engineering, National Research Council, Ottawa. It maintains a temperature of -30°C to -50°C at a pressure ranging from 0.05-0.10 Torr.

[4] This chemical is available from Embalmers' Supply Corporation, Rexdale, Ontario.

Evisceration of the animal through a midsagittal ventral incision into the thoracic and abdominal cavities is the next step. When the gastric and intestinal contents have been flushed out through a number of small incisions, the viscera are extracted, placed in a jar with Meat Packing Solution (Table 1) and kept for a minimum of four hours at a temperature of approximately 10°C. Starting with removal of the overlying skin, dissection of the major structures of the right limb follows. The skin over the upper portions of the left limbs is perforated to allow for the dehydration of these regions to provide minimal tissue destruction during the freeze-drying process. In a similar manner, trepanation of the skull assists in the effective preservation of underlying structures. The skull cap and adhering tissues can be severed from the cat's head and used as a lid to facilitate studies of underlying structures. In such a case, the brain is exposed and the meningeal coverings are micropunctured. The major joints, i.e., elbow, knee and ankle, are injected with 2 cc of glycerin and massaged for maximum effect.

TABLE 1: *FORMULAE FOR MEAT PACKING SOLUTION AND COMMERCIAL MICROFIL® SOLUTION USED TO STORE CADAVERA*

Meat Packing Solution	
Sorensen's solution - pH 6.4[a]	1 liter
Ascorbic acid - sodium chloride solution[b]	1 liter
Prague Powder solution[c]	1 liter
Formalin	150 ml
Microfil® Solution[d]	
MV-dilutent solution	30 ml
MV-132 clear Microfil® solution	24 ml
Catalyst	1.6 ml

a. *Sorensen's solution - pH 6.4 contains 2.73 gm of Na_2HPO_4, 7.27 gm of $NaH_2PO_4H_2O$ and 1 liter of distilled water.*

b. *Ascorbic acid-sodium chloride solution contains 1.7 gm of ascorbic acid, 7.65 gm of NaCl and 1 liter of distilled water.*

c. *Prague Powder solution contains 0.51 gm of $NaNo_4$, 0.34 gm of $NaNO_3$, 7.65 gm of NaCl and 1 liter of distilled water.*

d. *Commercial Microfil® is available from Canton Biomedical Products Ltd., Boulder, Colorado, U.S.A.*

As previously described for the viscera, the whole specimen is kept in a Meat Packing Solution prior to being placed in the freeze-dryer. It is first wrapped in gauze. The procedure of wrapping is important, since it determines the ultimate shape of the structures and, to a certain extent, the time required for freeze-drying. We determined that the best material for this was cheesecloth strips. All structures are separated by at least two layers of cheesecloth and, whenever possible, larger muscles are individually wrapped. The structures are then "shaped" manually *in situ*, so that the correct shapes and relations are preserved, and finally, the entire specimen is firmly wrapped and soaked in Meat Packing Solution for two hours. Afterwards, the specimen is put into a freezer, preferably at -30°C or lower.

FREEZE-DRYING PROCEDURES FOR A CAT SPECIMEN

The second step is freeze-drying. Weighed specimen is placed in the chamber of the freeze-dryer. For the next two or three weeks the specimen is weighed every second day, during which time the unit is defrosted. When the weight of the specimen stabilizes, it is removed.

POST FREEZE-DRYING PROCEDURES FOR A CAT SPECIMEN

The post-drying treatment is the third step in preservation. When the specimen is removed from the freeze-dryer, it is stripped of wrapping bandages while avoiding damaging any structures that have become brittle, i.e., nerves and vessels. Small holes are drilled in both ends of the long bones of the extremities of the specimen, which is then immersed in an acetone bath for 4-8 hours. After this period of time it is taken out and massaged to make joints and muscles more flexible. At this point, the brittleness - lost in the acetone bath - no longer poses any problem. Any remaining cheesecloth wrapping can be removed. The specimen is allowed to dry under a fume-hood for four hours. An aqueous solution of 25% glycerin is then massaged into the tissues to increase softness and flexibility and to leave a thin coating of glycerin on the treated tissue surfaces.

The specimen is now treated with a Microfil® mixture (Table 1) with a dilutent and catalyst. A clear mixture is rubbed on either alone or preceded by a small amount of a red-coloured mixture. If required, plastic chips may be used to separate structures and keep them from sticking to each other, before the Microfil® gels. The specimen is left in Microfil® for 24 hours, after which the surface of the specimen is rubbed with gauze or cheesecloth. This will cause the gloss to give way to a more natural appearance. To minimize tissue damage, care is taken to rub parallel to the direction of muscles and nerves. In the case of a specimen with the skull cap severed and the brain exposed, a protective coating to the brain may be applied with a clear plastic spray; any of the commercially available plastic sprays give good results.

Finally, the viscera that have been treated along with the main structures of the animal are put back into the thoracic and abdominal cavities. Suturing of the tracts and the main vessels to the body wall secures correct positioning of the viscera. And finally an ordinary hair conditioner is used to groom the cat's fur.

FREEZE-DRYING VARIOUS SMALL ANIMAL SPECIMENS

Smaller specimens or small whole animals, e.g., frogs, fish, snakes, etc., can also be freeze-dried. In general, the procedures for these specimens are identical to those for the preparation of a cat as described above, but with certain differences. The dissection procedure can be simplified and may even be totally eliminated. The smaller size of these specimens requires less freeze-drying time than for larger specimens. The dissection may be carried out in a number of different ways to suit the use of the prepared specimen.

A combination of preparation procedures was used to preserve a yellow perch for teaching purposes. After perfusion with latex, a dorsal-ventral incision is made, splitting the animal in half with the bones, fins (except for one pectoral fin) and the viscera left intact and attached to one half, with only cutaneous and muscle tissue left on the other. The latter half is treated according to freeze-substitution techniques in an alcohol solution; the former half is prepared by the freeze-drying method described above for the preservation of a cat specimen. Subsequent fitting back of the two halves is made easier when this combination of procedures is used. Final treatment with Microfil® is the same for both halves.

Smaller animals, e.g., insects, are best treated first by alcohol substitution, then freeze-drying methods and finally with glyceride and plastic spray. When the need for structure preservation is not critical, simple substitution techniques with antibacterial and colorant additives suffice.

DISCUSSION

The methodology described in this paper is low-cost. It has been successfully used in the preparation of all the animals mentioned in the Introduction. When more sophisticated specimens for display in a museum or for a specific regional animal study are required, several changes in procedures are necessary. This paper describes only the standard procedure of freeze-drying and several variations of this standard procedure will be reported elsewhere.

Mainly for two reasons it is felt that changes should be made in the area of provision of biological specimens used in teaching the biological sciences:

1) *Cost of Specimens:* Inflationary trends have made the traditional commercially available products in this area increasingly costly. Low-cost methods of preparation of biological specimens would make specimens available at a more affordable price.

2) *Ecological Considerations:* It is desirable to ensure that as few specimens as possible be taken from the wild into the laboratory or class room for teaching purposes. It is very difficult to estimate the toll taken from our flora and fauna in the name of education, but it is indisputable that the fewer that are taken the better. Well-preserved specimens would require less destruction of live specimens.

For the past four years, we have used for two university courses specimens prepared by this freeze-drying method. Students have handled these specimens freely, and while some of them started to show slight evidence of handling after the second or third year, all are still in perfectly acceptable condition after their fourth year. Other specimens, which were prepared with the same method and which have not been handled in instruction at all, show no signs of deterioration after four years. We venture to guess that a specimen may well stand up for a decade in instruction use, if its handling is controlled.

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FREEZE-DRYING AT THE NOVA SCOTIA MUSEUM

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WRIGHT, B. 1983. Freeze-drying at the Nova Scotia Museum. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 65-67.

ABSTRACT- A simple, inexpensive system for freeze-drying small animals is described. This freeze-dryer has been used successfully in preparing small mammals, small birds, spiders and caterpillars. Large specimens are placed in a Lucite drum and small specimens in vacuum chambers. The components were purchased in 1974 at a cost of $950.00.

RESUME- La communication décrit un système simple et peu coûteux de lyophilisation des petits animaux. La méthode a été utilisée avec succès pour la préparation de petits animaux, de petits oiseaux, d'araignées et de chenilles. On dépose les gros spécimens dans un récipient en Lucite et les petits sous des cloches à vide. Le matériel a été acheté en 1974 au coût de 950$.

INTRODUCTION

Much has been written concerning the theory and practice of freeze-drying. Several highly technical papers are available but it was felt that freeze-drying systems did not have to be that complicated. Basically, freeze-drying is the removal of water from a frozen specimen. This process occurs slowly in a frost-free freezer without any special apparatus but it is hastened by applying a vacuum and a desiccator. Our system, constructed in 1974, accommodates either large specimens in a Lucite drum, or small specimens in several vacuum chambers.

LUCITE DRUM

The thawed or fresh specimen is arranged using pins or other supports and then frozen in the drum in the freezer. The following day the drum is pumped down to 0.1 mm of mercury and the condenser filled with dry ice and alcohol. Accumulated frost is removed from the inner wall of the condenser every day, the dry ice replenished, and the entire system again pumped down. This procedure is repeated, at increasing time intervals, for up to eight weeks depending on the size and nature of specimens. At the outset we kept weekly records of weight loss of the specimens and it was found that in most cases, weight stabilized at five to seven weeks. Handling interrupted the freeze-drying and it was felt that frequent weighing would have an adverse effect so the practice was discontinued. We now allow two months for most specimens.

VACUUM CHAMBERS

These have been proven to be the most practical. We prepare insect larvae, spiders, small

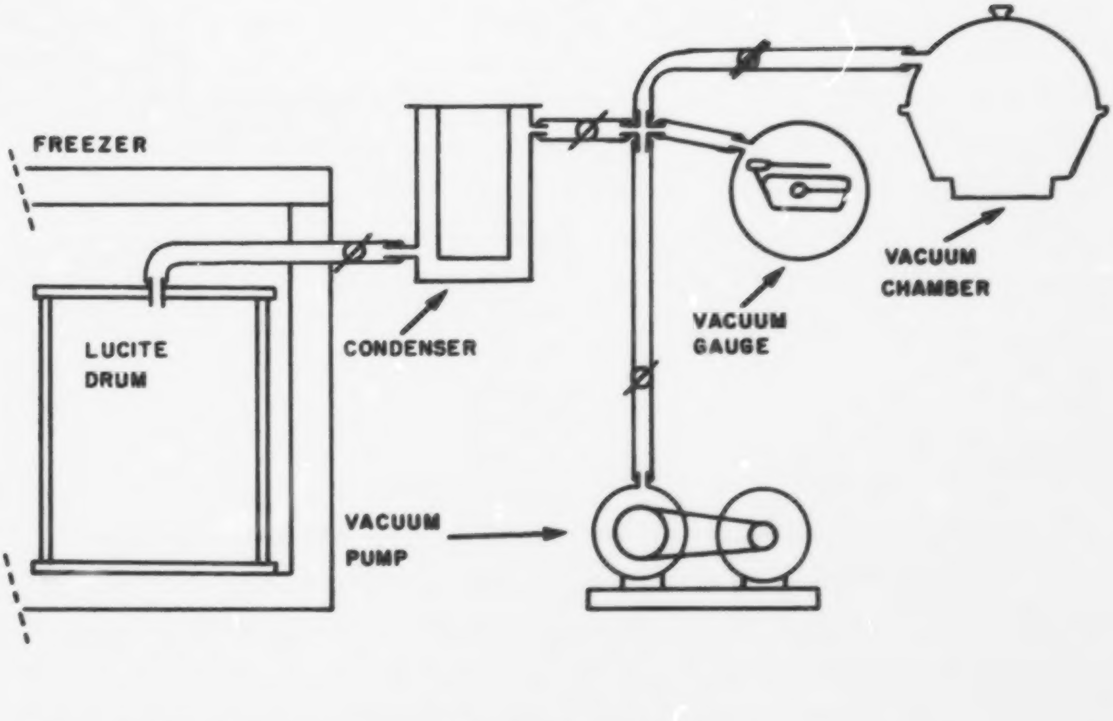
FREEZER
LUCITE DRUM
CONDENSER
VACUUM GAUGE
VACUUM CHAMBER
VACUUM PUMP

FIGURE 1: *The freeze-drying system at the Nova Scotia Museum.*

birds (warbler size), fungi and a variety of other material with minimal effort. As with the drum, specimens are arranged (usually held in position with insect pins on corrugated cardboard) and frozen in the chambers for a day or more before being pumped down. We place indicator silica gel in the base of each chamber as a desiccant, and change it as often as required. Specimens are left in the chambers in the freezer for six weeks and the chambers are pumped down frequently during the first two weeks. Table 1 lists the individual components of our system.

TABLE 1: *List of freeze-drying components[a] used at the Nova Scotia Museum*

Household chest freezer[b] - Gilson 15 cu ft
Lucite drum - 12 in diameter, 16 in high
Condenser - Virtis model 10-117A
Vacuum gauge - Virtis
Vacuum chamber - Bel Art, 8 in diameter
Vacuum Pump - VacTorr 25 (complete with 1/3 hp General Electric motor)

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a. These components (less freezer) were purchased from either Fisher or Canlab in 1974 at a cost of $700.00.

b. chest freezer cost $250.00.

DISCUSSION

We have found freeze-drying to be extremely useful in preparing study specimens of warblers and other small birds which are difficult to prepare as study skins. Small mammal study skins are usually accompanied by associated skulls and thus are not prepared by freeze-drying unless they have become dried out in the freezer or are required for exhibits. Freeze-drying is an excellent way to prepare spiders for reference or display purposes but there have been many failures due to improper freezing or thawing during pump-down which, so far, has been done outside the freezer. We have had consistently good results with the larvae of Lepidoptera. Fungi retain their form but their colours tend to fade during preparation. Notable failures have been fish, which appear waxy when dried, and amphibians which become bloated (probably due to improper freezing).

STORAGE OF SPECIMENS / RANGEMENT DES SPECIMENS

GLYCERIN AS A PRESERVATIVE FOR IMMATURE INSECTS

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DANG, P.T. 1983. Glycerin as a preservative for immature insects. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 69-70.

ABSTRACT- Glycerin is an excellent preservative for preserving living animal tissues, especially insects. Soft-bodied immature insects preserved in glycerin show many advantages over those preserved in the other commonly-used alcoholic preservatives, ethyl and methyl alcohol. At room temperature glycerin is chemically stable, does not evaporate, and remains in the liquid state. Owing to this non-evaporative property of glycerin, preserved specimens are protected from drying out in containers; this reduces the time-consuming annual ritual of inspecting and refilling storage containers. Moreover, specimens preserved in glycerin stay fairly flexible so that necessary dissections can be performed when required. Pigmentary colors of preserved specimens disolve slowly in glycerin so colors are preserved better and longer. After being impregnated with glycerin, a specimen can be safely removed from the preservative, washed and observed as a dry specimen for a long period of time without danger of shrivelling and complete deterioration; this gives the observer more time and freedom in manipulating study specimens. Finally, owing to the highly viscous property of glycerin, preserved specimens in a fully filled and tightly capped container are suspended in the fluid preservative which prevents physical damage to delicate specimens during transportation when sloshing movements are most prevalent.

RESUME- La glycérine est un excellent agent de conservation des tissus animaux vivants, en particulier des insectes. La préservation des jeunes insectes à corps mou dans la glycérine présente de nombreux avantages par rapport aux autres méthodes couramment utilisées, fondées sur l'emploi d'alcool, d'alcool éthylique et d'alcool méthylique. A la température ambiante, la glycérine est chimiquement stable, ne s'évapore pas et demeure à l'état liquide. Parce que la glycérine ne s'évapore pas, les spécimens conservés ne se déshydratent pas dans les contenants; le temps qu'il faut consacrer chaque année à l'inspection et au remplissage des contenants se trouve ainsi réduit. En outre, les spécimens conservés dans la glycérine restent suffisamment souples pour que l'on puisse procéder aux dissections nécessaires. Les pigments des spécimens conservés se dissolvent lentement, de sorte que les couleurs se conservant mieux et plus longtemps. Imprégné de glycérine, le spécimen peut être retiré sans danger de l'agent de conservation, lavé et observé pendant une longue période sans que le spécimen séché soit menacé de rétrécissement ou de dégradation complète; l'observateur a donc plus de temps et de latitude pour manipuler les spécimens d'étude. Enfin, en raison du coefficient élevé de viscosité de la glycérine, les spécimens conservés dans des contenants

remplis à capacité et bien fermés sont bien suspendus dans l'agent de conservation fluide, ce qui protège les spécimens délicats contre les dommages dus au clapotis qui se produisent lors de leur expédition.

A STORAGE SYSTEM TO REDUCE THE EXPOSURE OF ANIMAL COLLECTIONS TO LIGHT

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FABER, D.J. 1983. A storage system to reduce the exposure of animal collections to light. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 71-73.

ABSTRACT- A storage system to reduce the exposure of preserved animals to natural and artificial lights is described. It consists of black bottles which hold clear glass vials and stacking plywood boxes which hold the black bottles.

RESUME- La communication décrit un système de rangement qui permet de réduire l'exposition à la lumière naturelle ou artificielle des animaux conservés. Il s'agit de bouteilles noires contenant des fioles en verre transparent et de boîtes superposables en contre-plaqué où sont rangées ces bouteilles noires.

INTRODUCTION

Most animal specimens in museum or other permanent collections are held in clear glass vials or bottles. Normally these specimens are kept on shelves in wooden or cardboard boxes in taxonomic groupings. In this manner, specimens are directly or indirectly exposed to artificial lights, either fluorescent or incandescent, while some are even directly exposed to sunlight. A good museum-type cabinet would protect the specimens from light but in most institutions there are always periods of months or years before specimens are put away into light-tight cabinets. Normally, curators have plans for complete light control, when funds and facilities become available. I found that large numbers of small animals could be stored completely protected from all light with a little wood, paint, plastic and glass.

The term chromatophore is derived from the name cromoforo which Sangiovanni coined in 1819 for the active chromatic bodies responsible for colour changes in cephalopods (Parker 1948). Chromatophores are of many kinds but for descriptive purposes can be classified by colouring matter within them. The most common chromatophores contain brown or black pigments and are called melanophores. It is known, however, that all melanophores are not uniform in morphology, physiological reaction or even biochemical composition. In fact, all melanophores probably do not even contain true melanins. Chromatophores that contain red or yellow pigments, which are soluble in alcohol, ether or other similar reagents are called lipophores;

and yellow cells are called xanthophores. These latter cells all probably contain carotenoids.

Patterns of pigmentation are important morphological characteristics of many animals and are often included in basic generic or species definitions. It is well-known that certain pigments either change colour or disappear completely when placed into preservative fluids and that colours gradually fade after time in storage. Since pigment patterns on certain animals may vary by either genetic (Gooderich 1939, Foyn and Gjoen 1954) or environmental means (Carlisle 1955), it is desirable that they be retained as long as possible in permanent museum collections. It is hoped that the use of this relatively cheap storage system will help to reduce the fading of important melanophores and to maintain the black colour of others.

A STORAGE SYSTEM TO REDUCE EXPOSURE TO LIGHT

A storage system was designed to hold the eggs, larvae and juveniles of fishes but any small animals will fit as well. Animals are placed in preserving fluid in small glass vials (29 mm x 11 mm) with pop-in polypropylene caps (or cotton batting). These vials (12 or less) are held in 500 ml (16 oz) widemouth bottles (10.2 cm, 4 in high) with polypropylene covers. The inside bottoms are covered with cotton batting to prevent breakage of vials. These bottles are then filled with preserving fluid. The exteriors of the glass bottles are painted with black enamel (Sign Painters 1-shot Lettering Enamel, 199-L black)[1]. These bottles are packed in a collection box (Fig. 1) constructed of 1.25 cm (1/2 in) plywood with a sliding cover constructed of 32 mm (1/8 in) opaque black Plexiglass (No. 2025).

These boxes were built to stack so that the bottom of one fits inside the top of another. Measurements of the collection box are as follows: 32 cm (12 1/2 in) (o.d.) wide, 42 cm (16 1/2 in) (o.d.) long and 13 cm (5 1/8 in) (o.d.) high. The interiors of the boxes were painted a flat black. Each box, which holds twelve bottles, cost about $40.00 to construct.

DISCUSSION

This storage system is presently being used to hold larvae and juvenile fishes.

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[1] This paint is available in local stores but is manufactured by Consumers Paint Factory, Inc., Gary, Indiana.

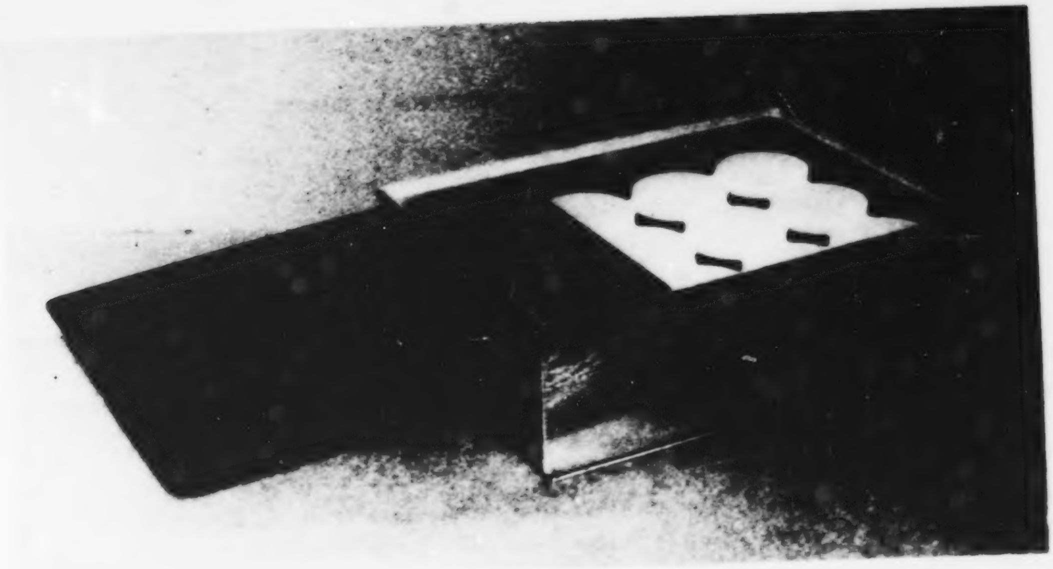

FIGURE 1: *Collection box showing bottles inside.*

At present there is insufficient evidence to determine that this treatment effectively slows down fading. It is well-established, however, that light causes some fading of animal colours.

Various fluids containing antioxidants and other chemicals have been proposed as long-term preservation fluids but formalin and various alcohols remain the most popular fluids. Adding certain antioxidating chemicals to preservation fluids will retain certain colours but not others. The retention and fading of coloured animal pigments, mainly carotenoids, pyrrols, quinones and indoles (including melanins), remains a complex and little understood subject. Substantial progress in this area can only be made by biochemists. At this time, the only way to document the colours of living animals is with coloured photographs.

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THE WET-EPOXY-SURFACE TECHNIQUE OF CASTING WITH POUR-IN-PLACE POLYURETHANE FOAM

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FITZGERALD, G.R. 1983. The wet-epoxy-surface technique of casting with pour-in-place polyurethane foam. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 75-78.

ABSTRACT- Casting large, complicated-shaped objects, such as skulls and antlers, can present problems of distortion along seams when typical polyester resin, 2-part casts are made. When a cast is made all-in-one with epoxy resin, shrinkage and distortion are reduced but sometimes other difficulties arise in building up enough thickness to give the cast sufficient strength. These problems are overcome when the inside surface of the mould is coated with thickened epoxy and the mould is assembled and filled with polyurethane foam while the epoxy is still wet. Detailed steps to cast large objects with this new technique are given.

RESUME- Le moulage des gros objets complexes, comme les crânes et les bois, peut présenter des problèmes de déformation le long des joints lorsque l'on construit ces objets en deux parties et en utilisant de la résine polyester. En faisant un moulage tout d'une pièce avec de la résine époxyde, on réduit la déformation, mais d'autres problèmes apparaissent parfois lorsqu'on veut, en lui donnant une certaine épaisseur, rendre le moulage suffisamment résistant. Pour résoudre ces difficultés, on revêt l'intérieur du moule de résine époxyde épaissie, puis le moulage est monté et rempli de mousse polyuréthanne pendant que la résine époxyde est encore humide. La communication donne, étape par étape, la façon de mouler de gros objets selon cette technique.

INTRODUCTION

Casting is a complex procedure during which problems often occur. While casting a skeleton of an extinct giant moose (*Cervalces scotti*), the problem of how to handle the skull and antlers arose. A traditional latex mould supported by a plaster reinforcing jacket was made. To fill the mould the two halves were surfaced with epoxy resin and subsequently laminated with polyester resin. Once cured, the edges were built up with a wet paste of epoxy thickened with Cab-O-Sil® (a pyrogenic colloidal silica produced by Cabot Corporation) and the two halves of the mould were put together while the epoxy was wet. The finished cast showed distortion around the seam. Obviously, for a specimen of this size the technique was unsuitable and a new approach was required.

It was decided to try a combination of an epoxy surface backed by expanding foam which therefore required a stronger mould. A new two-piece latex and cheesecloth mould with a pour hole entering through the foramen magnum was made for the skull. Undercuts were filled with plaster keys and both mould and keys were supported by a two-piece fiberglass reinforcing jacket. The halves of the latex mould fitted together precisely by means of continuous tongue and groove marrying locks on the flanges. To further ensure a perfect fit, the fiberglass reinforcing jacket was bolted together through the flanges of the latex mould (Fig. 1). Now, no matter how quickly it was necessary to work, there would be no doubt that the mould was fitted precisely and firmly together.

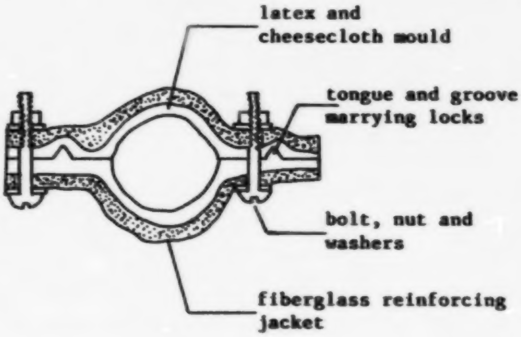

FIGURE 1: *Cross section of mould and reinforcing jacket.*

Although the general principle of an expanding foam and epoxy technique had been decided on before designing the mould, it was necessary to give the casting process further thought. Certain high density foams which are self-skinning are on the market but they are not generally available in small quantities. Two-pound pour-in-place polyurethane foam is available but it produces an inadequate surface. Other workers use thin skins of plastic (polyester or epoxy), place the halves together, then backfill the cast with foam to support the thin surface. This technique has drawbacks for complex objects such as skulls. How can it be ensured that a latex mould will fit perfectly into the reinforcing jacket? When the fit is poor, would expanding foam crack the thin resin surface? Would distortion arise as the surface coat is cured? Would the halves fit properly together? There are many problems but experimentation provided a new technique.

THE WET-EPOXY-SURFACE TECHNIQUE OF FOAM CASTING

1) Thicken epoxy resin with Cab-O-Sil® so that it is sufficiently viscous to stay on the stirring stick and paint it into the halves of the mould being sure to run a bead around the edges (Fig. 2). Put on 1/16" to 1/8" of epoxy. Work quickly to get the epoxy into the mould, since its pot life is short. However, once spread in the mould, the epoxy cures much more slowly because the heat produced in curing is quickly dissipated.

2) While the epoxy is wet bolt the halves of the mould together.

3) Pour the two-pound polyurethane foam into the mold while the epoxy is still uncured. Pressure is maintained in the mould by holding a wad of paper towel over the pour hole.

4) Although the heat produced by the foam accelerates the curing of the epoxy, it is advisable to leave the cast overnight before opening the mould.

The procedure is quite straight forward for those who are familiar with casting but there are a few notes of caution: Experiment with the foam to determine the amount required because its true rate of expansion can vary. Slightly over-fill the mould with foam to pressurize the interior. The epoxy must be mixed to a creamy consistency that will not flow. If it is too thick and dry, it will not brush on smoothly thereby creating air bubbles and will not pick up all the surface detail of the mould; if it is too thin, it will run down the mould and reduce the foaming of the polyurethane foam. Pour the foam into the mould just as the foaming action begins. Be warned that polyester resin cures too quickly to be used with this technique. And finally always use a separator in the mould.

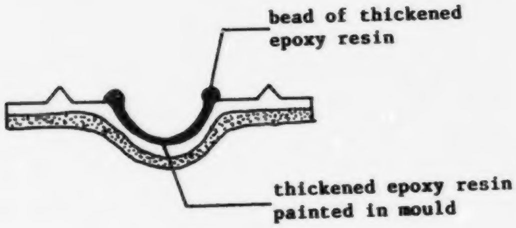
bead of thickened epoxy resin
thickened epoxy resin painted in mould

FIGURE 2: *Half of mould showing bead of thickened epoxy resin used to join halves together.*

DISCUSSION

This technique produces excellent results: the seams are well aligned because everything is wet when the mould goes together and the precise locking method of the mould limits distortion. The surface detail is excellent. The thickened epoxy which coats the inside of the mould has high resolution for detail and to some extent, is forced into the irregularities of the mould by the pressure of the expanding foam. Since the epoxy is not fully cured when the foam is poured, it does not split or crack. The general form of the cast is excellent. The pressure of the expanding foam forces the latex mould tightly against the reinforcing jacket. The resulting cast is light and strong. If the casting project is planned properly, the supporting structures for mounting can be "foamed" into place during the casting process.

For complex branching shapes like antlers, the latex mould and reinforcing jackets can be designed in sections. By working quickly, the sections can be built up and poured continuously without waiting for the materials to cure. This results in a cast that looks cast all-in-one. It is important to carefully judge the amount of foam to be used in each section as overflow can cause problems. Slightly under-fill each section with foam except the last one which is slightly overfilled.

CASTING FOSSIL FOOTPRINTS IN A LIMITED-ACCESS TIME LOCATION

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GRANTHAM, R.G. 1983. Casting fossil footprints in a limited-access time location. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 79-87.

ABSTRACT- The most significant find of a vertebrate trace fossil in Nova Scotia recently was the discovery of large footprints in siltstone of Mississipian age at Horton Bluff, Kings County. This paper gives a short history of the find and details the procedures used to make a permanent record of the footprints.

RESUME- La découverte d'empreintes laissées par des vertébrés de bonne taille dans un siltstone du mississippien à Horton Bluff, dans la comté de Kings en Nouvelle-Ecosse, ne manquait pas d'importance. Comme le site n'était à découvert qu'à marée basse, il fallait nettoyer les empreintes, les sécher, préparer le matériel, procéder au moulage et ramener moulage et matériel en moins de 7 heures. L'article relate brièvement l'historique de la découverte et expose le détail des procédés utilisés pour obtenir une copie permanente des empreintes.

INTRODUCTION

In 1841 the first evidence of reptilian footprints from Carboniferous age rocks was found by Sir William E. Logan at Horton Bluff, near Avonport, Nova Scotia (Logan 1842). This find provided the first record of the oldest known reptiles. Unfortunately his paper given at the Geological Society of London describing this find did not receive wide acceptance. Worldwide acclaim was given in 1844 to a German scientist, E.H.C. Von Dechen, for his find of reptile bones (Dawson 1863) and to A.T. King, an American scientist, for his discovery of footprints in the rocks of Pennsylvania (King 1845).

In Canada in 1964 two students working for the Nova Scotia Department of Mines noticed large footprints in siltstone exposed at Horton Bluff on the shores of Minas Basin. The footprints remained known but undocumented for nearly thirteen years. In 1978 a paper by Dr. William Sarjeant and Dr. David Mossman (one of the two students of 1964) describing the record of footprints in the Carboniferous rocks of Nova Scotia was published (Sarjeant and Mossman 1978).

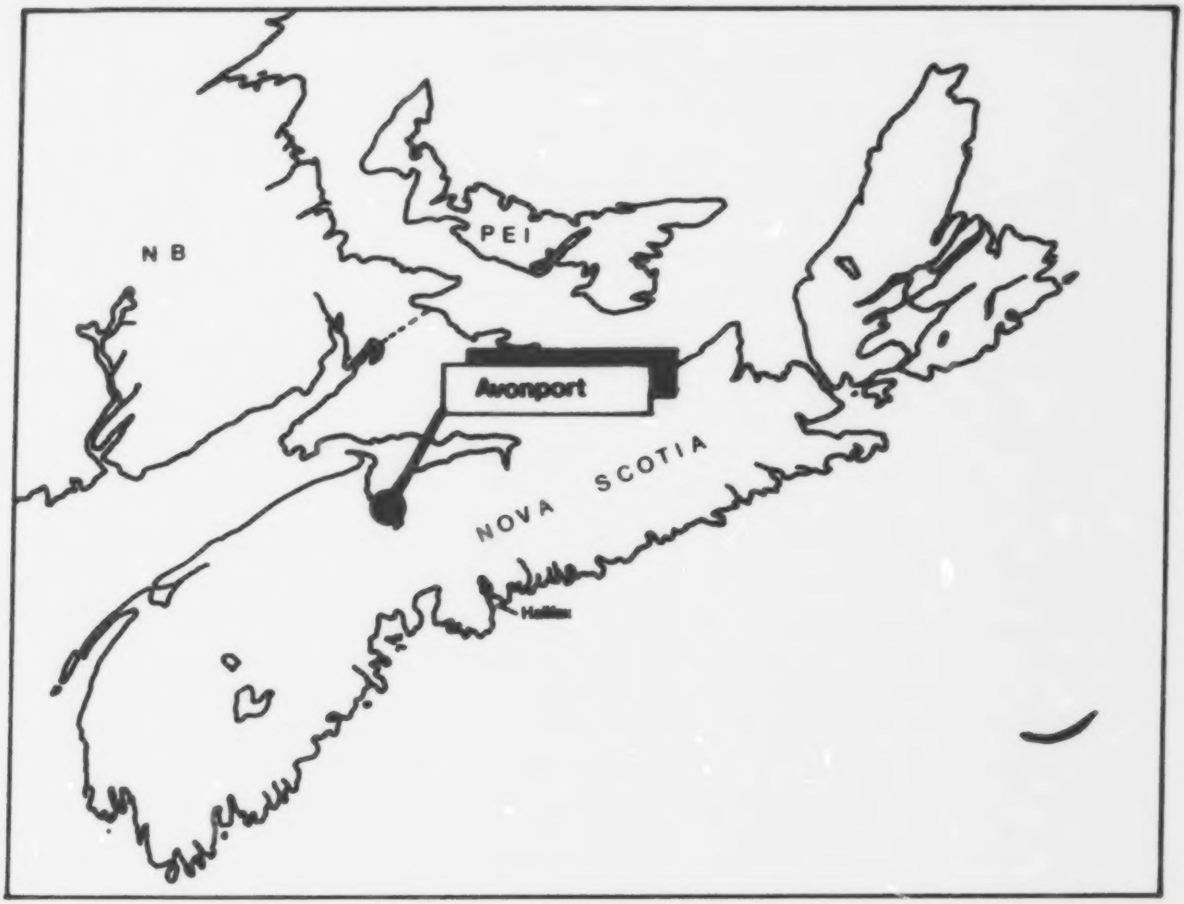

FIGURE 1: *Location of trackway at Avonport, Kings County, Nova Scotia.*

The local residents of the Horton Bluff area knew of the footprints but never bothered to inform the Nova Scotia Museum or anyone else of their existence. The footprints cannot be easily seen on the shore. Their location was disclosed to the Museum by Dr. Mossman when he visited Nova Scotia on holiday in the summer of 1979 and personally invited staff members of the Museum to view the footprints (Fig. 1). At that time it was decided to make a casting of the trackway so as to have a permanent record. The trackway contains 27 footprints each approximately 30 cm long and 15 cm wide (12 in x 6 in) in two slightly offset lengths measuring 20 metres (65 feet) from the first footprint to the last. Because it is exposed only at low tide, time available to wash, dry, prepare, cast and remove the casting and equipment from the site was limited to seven hours. Plaster of Paris, the usual casting medium, would not be suitable for the short casting time available, so it was decided to do the casting with fiberglass.

STORAGE OF SPECIMENS / RANGEMENT DES SPECIMENS

The area to be cast was buried under 10 to 20 centimeters of fresh Minas Basin red muds. These muds move back and forth and are shifted constantly by each tide change. During periods of storm activity the muds are removed from the bedrock by wave action. During normal tidal cycles with low amplitude waves, the mud has a tendency to accumulate to a certain depth and then remain relatively unchanged. The mud posed one of the most serious problems; it had to be entirely removed from the bedrock. It was feared that even a small amount of water soaked mud lying in a crack or crevice would cause the resin not to harden as the heat required for the hardening may be conducted away. This fear proved unfounded and no such problem arose.

PROCEDURE

The site was prepared by shovelling, sweeping, scrubbing, mopping and sponging, the mud away (Fig. 2) and drying of the rock containing the trackway was aided by carefully directing an industrial, propane flame thrower at its surface (Fig. 3). This provided the required heat and blowing force to dry all water on the surface and most of the water in cracks and crevices. Barnacles which had grown on the raised portions of the footprints were removed with rubber hammers, sponges and knives. The length and width of the area to be cast was then marked out with pieces of masking tape. A sealing coat of ordinary household paste wax was then applied to provide a smooth surface by filling the minute irregularities in the rock and also to provide a moderate moisture barrier. Plasticine was then employed to fill all the undercuts (small rock overhangs in and beside the footprints). This was done to prevent the casting from locking itself to the rock.

FIGURE 2: *Cleaning the tracking of loose mud in order to expose it for casting.*

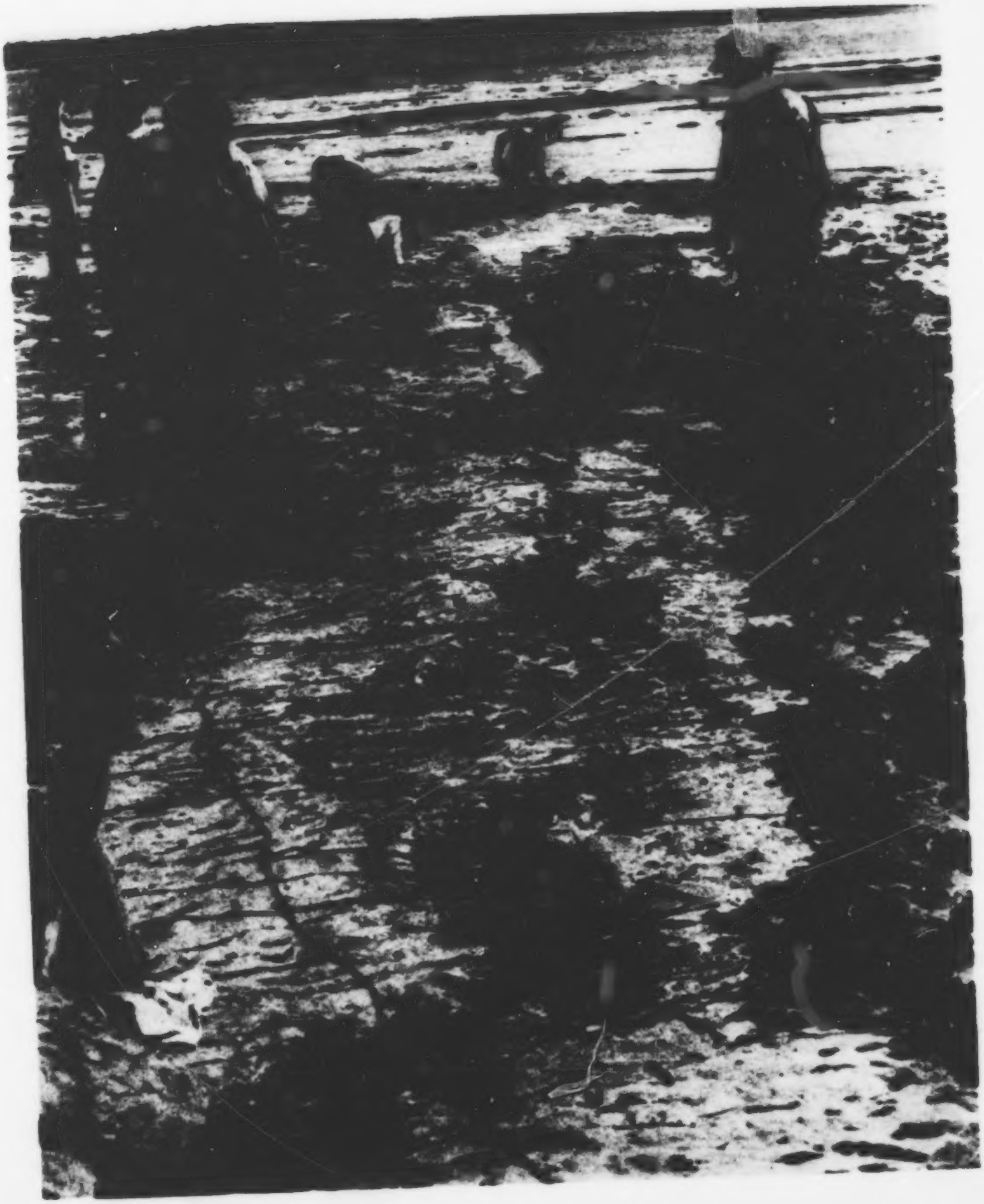

FIGURE 3: *Footprints in the bedrock. Note the offset caused by a small fault zone in the rock. A flame thrower is in use on the left; barnacles are being removed in the background.*

With all of the above preparations completed, a generous and thorough coat of Partall[1] was painted on the entire area to be cast. This was the separator coat and would provide the releasing surface for the finished and cured casting. Partall is easily removed from the finished casting with water. After the separator coat of Partall was applied, the individual tracks were filled with gelcoat[2]. After each footprint was filled, additional gelcoat was painted on the entire area of the trackway to be cast (Fig. 4). At this point the catalyst was mixed with the fiberglass resin and mats (random sizes but not exceeding 15 x 20 cm) of coarse glass fibers were readied. Mats and resin were then placed in the footprint depressions in order to add strength to those areas. Woven fiberglass cloth was trimmed to the width of the casting, cut into manageable lengths and then laid on top of the mats, ensuring the whole area to be cast was covered. The mats were made of pressed coarse glass fibers, whereas the cloth was woven fibers. Resin was poured onto the cloth and worked in with brushes so as to completely soak the cloth and provide a bond to the gelcoat. The fiberglass cloth and resin were laid down in overlapping sections, the cloth being originally held in place with rocks until the resin could be added. After the initial coat of resin and cloth had cured and hardened, existing air pockets were punctured and filled with resin. A final coat of resin was then applied to the entire casting (Fig. 5). After the complete casting had cured and hardened (approximately 1½ to 2 hours) it was cut into 1½ to 2 metre lengths with a portable, concrete slab saw equipped with a carborundum blade. It was then pried loose with shovels.

The casting operation began as the tide was just leaving the tracks and concluded before the tide covered them again with one hour to spare. The casting is now in storage at the Nova Scotia Museum and is awaiting study. This is a summary of the techniques and processes employed. A complete photographic record of the procedure was kept and is available upon request from the author.

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1. Partall is a product name for the parting agent purchased from Pastics Maritime Ltd., Halifax, Nova Scotia.

2. Gelcoat is the general term for the primary filling material. The product name is Shell Coat which is also available from Plastics Maritime Ltd.

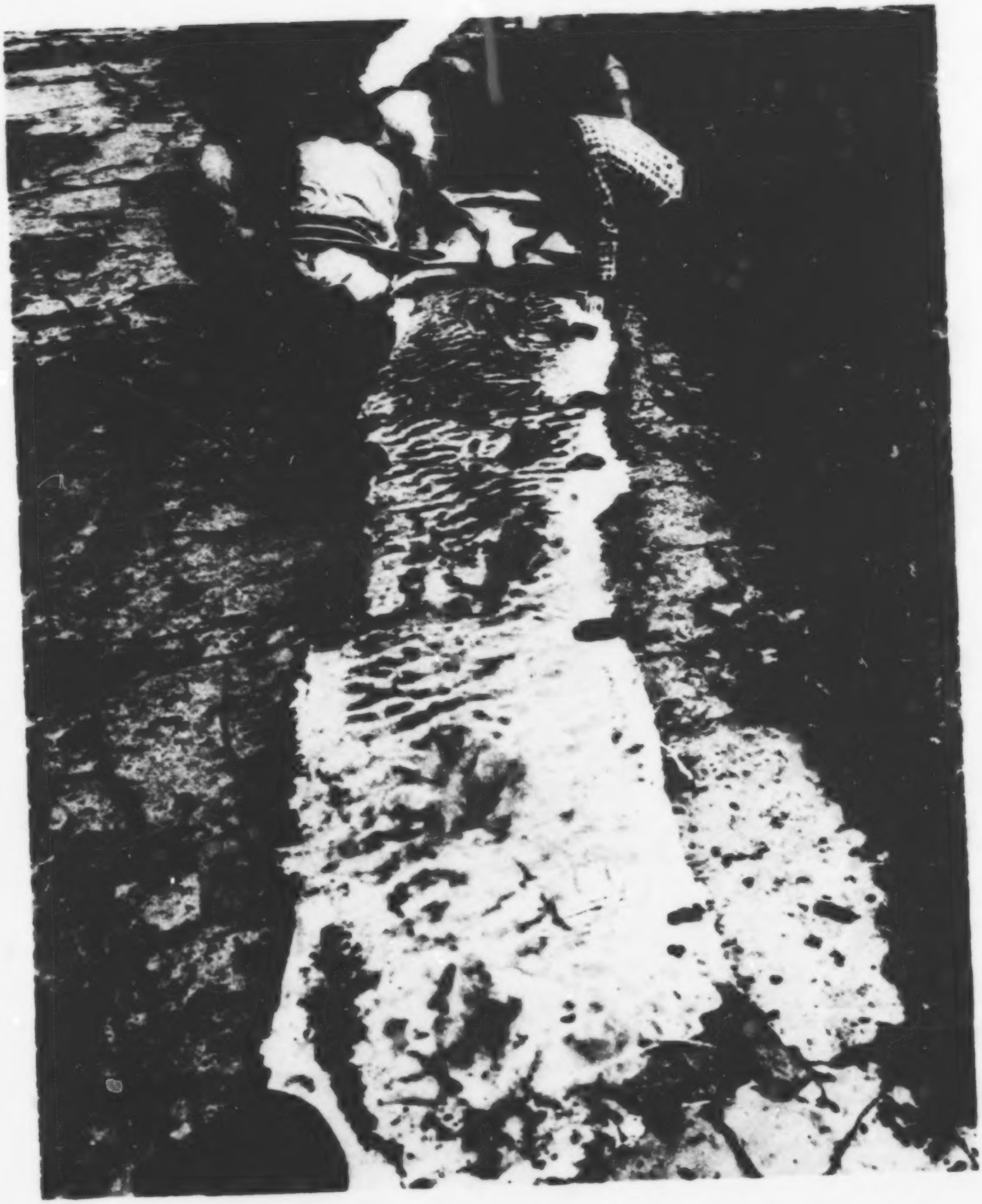

FIGURE 4: *Application of resin to the woven cloth. The underlying layers of gelcoat, mats and resin can be seen in the distance.*

FIGURE 5: *Casting nearing completion and being prepared for removal.*

ACKNOWLEDGMENTS

Complete success of the casting operation was the result of non-stop teamwork by the Nova Scotia Museum's Exhibits Section under the direction of Ed Longard, Chief Curator. The expertise of Lloyd Duncanson and Dave Coldwell in working with fiberglass was the key element in producing an accurate casting. The long hours of hard, muddy work by Azor Vienneau, Mike Murray, John Kemp, Kim Jarrett, Vince Cribby, Bill Dingle, Glen Buckmaster and two Science Section summer students Tracy Webb and Ken Tully is gratefully acknowledged.

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STORING INSECT SPECIMENS IN GELATIN CAPSULES

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HAMILTON, K.G.A. 1983. Storing insect specimens in gelatin capsules. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 89-91.

ABSTRACT- Dried insect and arachnid specimens can be safely stored in gelatin capsules. Benefits include compact storage, ease of curation, protection against accidental damage, immediate labeling and lengthy series easily integrated into dry collections.

RESUME- Les spécimens d'insectes et d'arachnides séchés peuvent être conservés en toute sécurité dans des capsules de gélatine. Cette méthode comporte de nombreux avantages: faible encombrement de l'entreposage, facilité de conservation, protection contre les dommages accidentels, étiquetage immédiat et intégration facile de longues séries dans les collections de spécimens séchés.

INTRODUCTION

One of the major problems a taxonomist and his institution must face is: how large a series should be preserved? Ideally the answer should be: "the more, the merrier." Long series are needed to establish variation patterns and verify host associations. Precise measures of variability require lengthy series. Rare varieties are unlikely to be recorded unless many specimens are examined, and selective collecting tends to over-emphasize the importance of variants in a population. On the other hand, in practical terms, collecting large numbers of specimens inevitably means greatly increased demands on space (for storage) and time (for preservation and curation). This paper describes a method for storing hard-bodied insects which saves both time and space.

Small and soft-bodied specimens have been preserved in bulk samples by means of fluid preservation. This has proven a great boon to entomologists and arachnologists, since such preservation techniques are not as time-consuming as individual mounting techniques. Fluid preservation is still not very efficient in saving space or allowing easy examinations. Fluids have other disadvantages, such as non-permanence, damage to colours, messiness and cost.

A viable alternative for relatively hard-bodied insects is dry storage in gelatin capsules. This method offers the best of several techniques: simplicity, good preservation, easy examination of individual dry-mounts, speed and utility of bulk-preservation, the ultimate in compact storage (with up to 100 specimens in the same space as a single pinned one), the convenience of integration of bulk-storage into the dry-mounted collection, and the overall protection of both specimens and data. The importance of the protective aspect cannot be overemphasized. Slides and dry-mounted individuals are vulnerable to many kinds of accidental damage (such as falling off their points) that are prevented by vial preservation. Incorrect data labels, the bane of any collection, are reduced since the specimens can be easily labeled by the collector himself within hours of making the collection.

GELATIN CAPSULE TECHNIQUE

Field collecting requires as equipment about a dozen cardboard pill-boxes, a small sheet of cardboard or paper, a soft paintbrush (squirrel hair does nicely) and a supply of capsules in addition to the usual nets, killing bottles, pins and labels. The newly-killed sample is placed in one of the pill-boxes (and labeled) where the specimens are allowed to air-dry for 2-10 hours. They are then emptied onto the card and sorted with the aid of the paint-brush. Specimens of one species are transferred with the aid of the brush into a capsule, and the data label is attached. Specimens so preserved may be carried for months in Schmidt boxes provided that excessive shaking is avoided. The normal motion of a car, for example, will not damage them.

Insect specimens, whether freshly killed, or removed from fluid, or from dry bulk preservation (such as pill boxes) can be placed in gelatin capsules of sizes 0 to 000 with a pin through the cap that also penetrates the body of the capsule. Data and any other associated material may be attached to the other half of the pin without leaving too little pin for secure insertion into a foam-bottom pinning tray. It is important that the specimens be dry before being placed in the capsule, or otherwise they will stick to its sides. The specimens are then, for all intents and purposes, permanently preserved.

When it becomes desirable to study the specimens, the pin is removed and the specimens are slid from the capsule onto another card for re-sorting. Manipulation of the specimens with the aid of the paint-brush is usually sufficient for most taxonomic work. If more detailed studies are contemplated, the specimen may be individually mounted on a point or pin. If the capsule is not kept under dry conditions the specimens may stick to the sides. Usually a slight jar will loosen them, but if this is undesirable or impractical then the whole capsule may be dissolved in water to recover the undamaged specimens.

Specimens that must be shipped by mail or other means involving agitation or frequent handling should be protected by inserting a small wad of cotton-wool or tissue paper, thus confining the specimens to one end. It is neither necessary nor desirable to insert such a wad into capsules in an undisturbed collection, as some damage may occur with the compression, or with the tarsal claws becoming entangled in the wadding. Nevertheless, specimens shipped in this manner will arrive in better condition than individually mounted ones.

THE GELATIN CAPSULE TECHNIQUE IN PRACTICE

I have been using the gelatin capsule method of preservation for over a dozen years now, ever since being introduced to it by my major professor, the late Dr. Herbert H. Ross. With the exception of a few early, and imperfectly preserved collections (from sticky boards) all are still in excellent condition. I have used these specimens in several major revisionary works, and find the characters to be generally more easily accessible than from pointed specimens, and the series themselves have been invaluable in solving numerous taxonomic problems. Repeatedly, I have found that specimens initially identified as being a single species have turned out to contain two or more species; and I am glad that I took the precaution to pick up a good series. Some species have proven to have disproportionate numbers of a single sex, and I should probably have completely missed one sex had I not collected numerous specimens. In this way I have been able to add an average 5000 specimens per year to the Canadian National Collection without needing technical help.

One more example is polymorphism in the leafhopper genus *Macropsis*. The majority of polymorphic species vary in predictable ways such as the distinctness of the tegminal banding. Others, however, have some bold color patterns completely unexpected in the "average" range of variation. *Macropsis suturalis* is wholly green, with a black stripe, while its colour variety *nigricans* is mottled brown, and *bicolor* is black above, and green, yellow or orange below. All were described as separate species and have been universally so regarded by subsequent workers. It has taken numerous samples of over 600 individuals on two different hosts to provide convincing evidence that they are all polymorphs of the same species. Fortunately, all 600 individuals fit into a single 4" x 8" pinning tray, and will be available for subsequent workers who wish to test the diagnosis.

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RELOCATION OF THE ROYAL ONTARIO MUSEUM'S INVERTEBRATE PALAEONTOLOGY COLLECTIONS, 1981

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WADDINGTON, J.B. and D.M. RUDKIN, 1983. Relocation of the Royal Ontario Museum's Invertebrate Palaeontology Collections, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 93-101.

ABSTRACT- The collections of the ROM Department of Invertebrate Palaeontology, comprising over 200,000 catalogued fossil specimens, were moved to improved and expanded facilities in June, 1981. A complex transfer procedure ensured that specimens and storage units arrived in the new quarters intact, and in sequence. Teams of professional movers and department staff accomplished the move in less than three days with a minimum of disruption.

RESUME- Les collections de la Section de la paléontologie des invertébrés du Musée royal de l'Ontario, qui contient plus de 200 000 spécimens de fossiles répertoriés, ont été installées dans des locaux plus vastes et mieux aménagés en juin 1981. Grâce à des méthodes de déménagement complexes mais opérationnelles, les spécimens et les unités d'entreposage n'ont pas été affectés et leur ordre n'a pas été bousculé. Des équipes de déménageurs professionnels et le personnel de la Section ont effectué le déménagement en moins de trois jours, avec un maximum d'efficacité.

INTRODUCTION

Prior to June, 1981, various invertebrate palaeontology functions were spread over several areas in the old museum building. Offices, a micropalaeontology clean-lab, a large cataloguing room (Fig. 1), and the main catalogued collection storage room (Fig. 2) were located on the second floor. A microfossil recovery lab and room for unpacking, washing, sorting, and preparation of macrofossils were in the basement. Storage cabinets for specimens were double and triple-stacked in the collection storage room, the cataloguing room, basement workroom, and in every available space along basement corridors.

Up to 1981 environmental conditions within the main ROM building were approaching intolerable levels for both staff and collections. Labs in the Department of Invertebrate Palaeontology were poorly ventilated and the basement workroom was periodically flooded during heavy rains. Climate control in the old building was next to impossible with its high ceilings, large windows and outdated heating system. Greasy dust was a constant problem and interior temperatures ranged from 14°C in winter to 35°C in summer. The relative humidity (R.H.) ranged from less than 5% to almost 100%. These violent fluctuations in R.H. caused deterioration of certain specimens. Pyritized fossils, notably Jurassic ammonites and crinoids, suffered badly from the acid environment produced by storage in oak cabinets and high R.H. On the other hand, Pleistocene subfossil wood had dried and warped in periods of extreme dryness. Almost as serious was the deterioration of old storage cabinets. The bulk of the catalogued collection was stored in oak cabinets, used in the original 1914 and 1932 galleries, which were fitted with cleats at 2 cm intervals to accommodate runners for drawers. Doors were originally tightly fitted with felt dust seals, but these had since disappeared through decay and insect damage. The wood was dried out and cracked, cleats were warped, and a number of cabinets sagged from the strain of being stacked and overloaded.

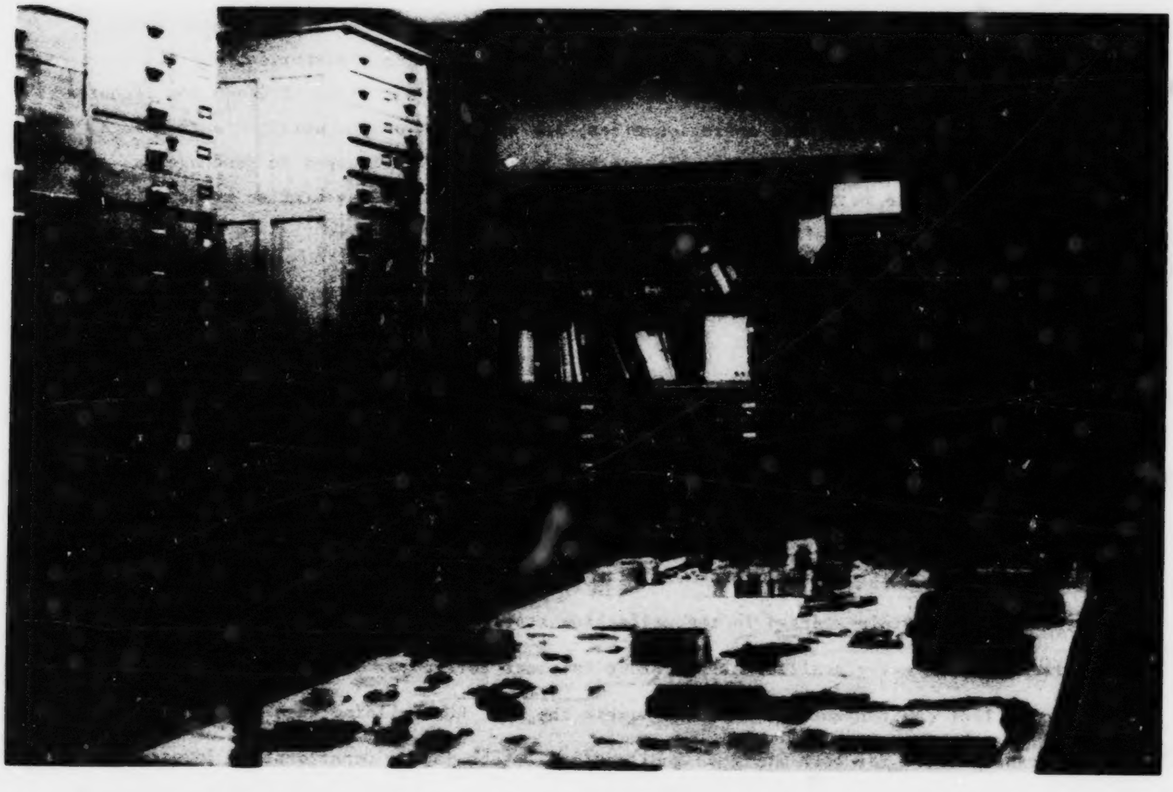

FIGURE 1: *Cataloguing workroom in the old building, showing birch cabinets double-stacked.*

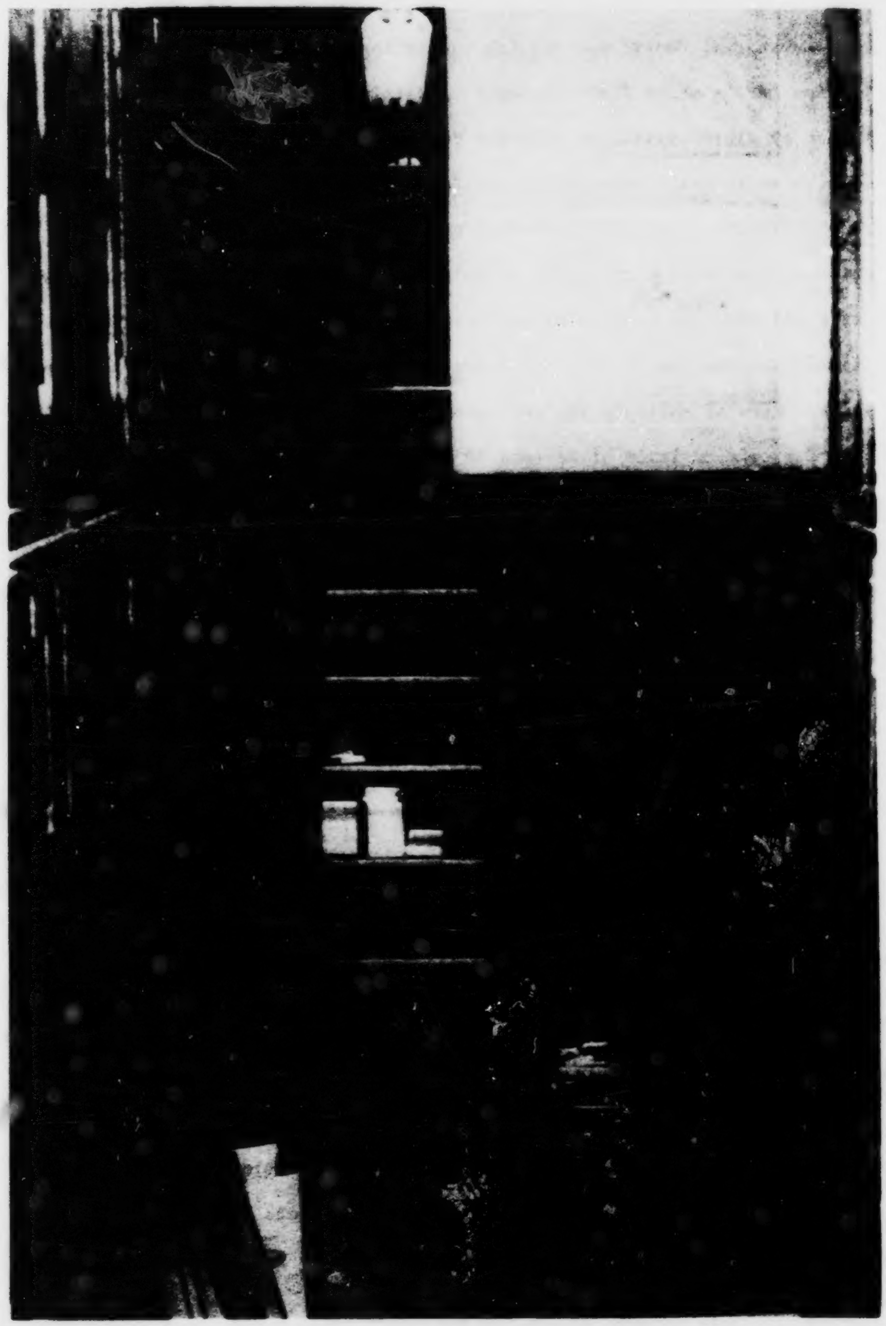

FIGURE 2: *Catalogued collection storage in the old building.*

NEW FACILITIES

In late 1977 plans were underway for expansion and renovation of the ROM and by early 1981 the new 9-storey Curatorial Centre was nearing completion. The invertebrate palaeontology facilities on the third floor include: adjoining labs for acid leaching and heavy liquid separation of microfossils, an adjacent clean lab for microscopy and storage of research microfossils, a macrofossil preparation lab, a large workroom for cataloguing, drafting and temporary storage of incoming material, and the collection room.

The new collection storage room, convenient to labs, offices, and freight elevator, is about 360 sq m in size allowing the previously scattered collections to be brought together in one place. A significant feature of the collection room is a central compacted storage system. In this system, rows of cabinets are set onto carriages which move along floor mounted rails. Space for only a single aisle need be provided since carriages are moved back and forth to provide access to the appropriate aisle. The carriages are moved electrically but can be shifted using a hand crank in the event of a power or equipment failure. A raised floor covering the rails permits easy access with ladders and will also accommodate stationary rows of cabinets. At present, there are two sets of rails with four carriages housing 71 new cabinet units. The units stack two high to about 2.7 m (9 feet) and the cabinets can accommodate old drawers as well as new ones. Large specimens are accommodated on pallet racking and steel shelving.

PREPARATION FOR MOVE

Preparations for moving the collections began in 1980 by drawing up a detailed inventory of all storage units and their contents. Storage units were divided into two categories: variable drawer and fixed drawer units. Variable drawer units, fitted with closely spaced cleats, support drawers of standard dimensions. Drawers may be spaced at varying intervals within the cabinets to accommodate specimens of different sizes and all drawers and cabinets are compatible. The cabinets are closed by lockable doors. These variable drawer units include the old oak cabinets and the new cabinets built for compaction carriages. Fixed drawer units have drawers of fixed depth which are not interchangeable. These units include old doorless standard (5'x5'x2'6") birch cabinets housing 20 drawers each, locked by hinged vertical strips at each end. Storage units with shelves rather than drawers were also included in the "fixed" category.

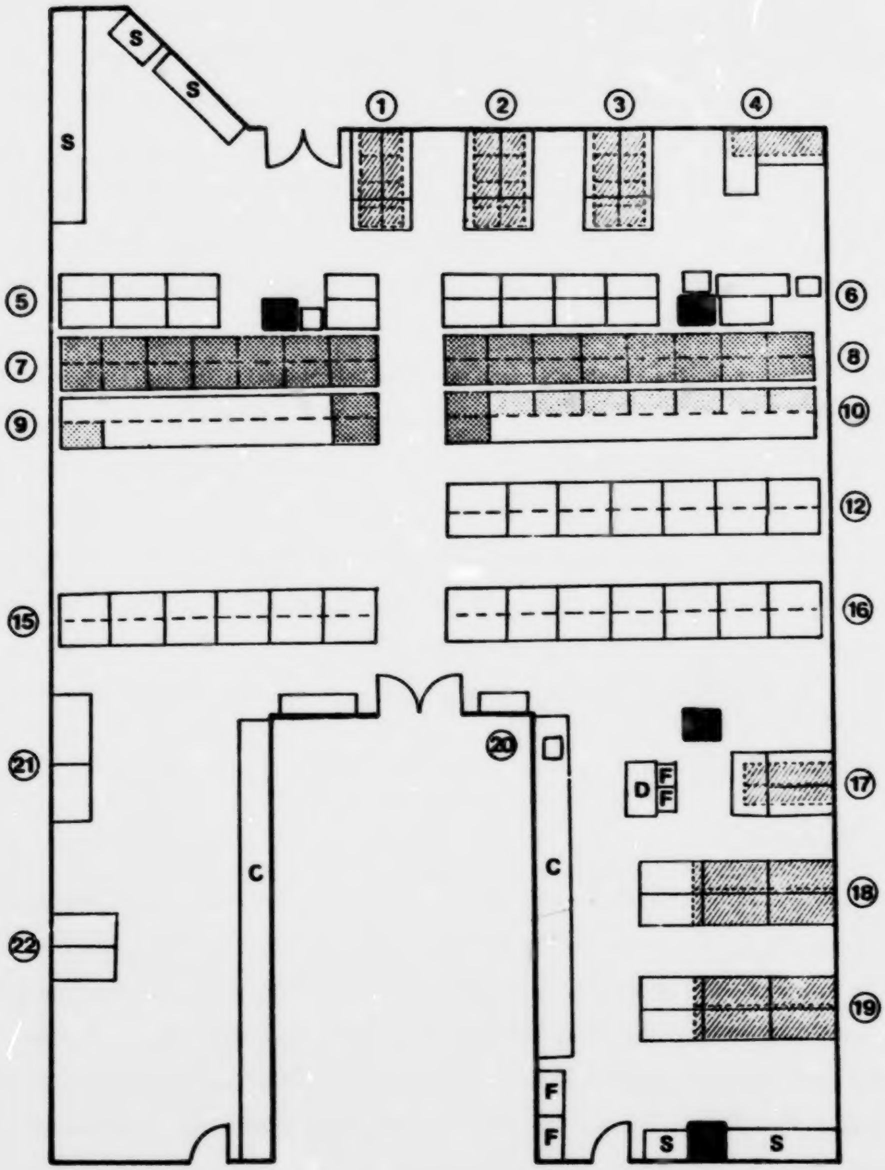

FIGURE 3: *Detailed floor plan of the new collection storage room. Light and dark stipple indicate new cabinets in compacted storage, single and double-stacked. Cross-hatching indicates double stacking. Old oak units (banks 5,6,12,15,16) are triple-stacked. C=counter, D=desk, F=card files, S=large specimen shelving.*

Collections were also divided into two categories. The first was catalogued specimens (including type and figured material). These have received a unique catalogue number, either individually or as a related lot, are fully curated and stored systematically. It was essential that order be maintained in each segment of this collection which includes over 40,000 specimen lots,.or over 200,000 specimens. Most of the catalogued collection was stored in variable drawer units. The second category was accessioned and research material. These had not been catalogued, and were stored mainly in fixed drawer units in offices, laboratories, workrooms, along the basement corridor, and off-site.

While the inventory was being completed, floor plans for the new collection room (Fig. 3) and labs were drawn up and a code devised for the ultimate position of all storage units. Blanks were left in the numbering of aisles in anticipation of eventually inserting additional carriages in the compacted storage area. All fixed drawer units were labelled with the code of their final position in the Curatorial Centre using self-adhesive labels provided by the movers. Each drawer was numbered within the cabinet and also with the cabinet position code. Catalogued material in variable drawer units was treated slightly differently. To keep the catalogued collections in order, a code number was assigned to each taxonomic group of fossils and the drawers numbered sequentially within each group. An elevation diagram of each row of units in the compacted storage area (Fig. 4) indicated the drawers to be placed in each cabinet. This ensured that even if drawers were handled out of sequence during the move they could be placed in or near their final position immediately, and rearranging would be kept to a minimum.

MOVE TO CURATORIAL CENTRE

The physical moving of the collections was carried out by two teams of professional movers, one in the old area and one in the Curatorial Centre, supervised by departmental staff and museum co-ordinators. Contact was maintained between the two groups by means of a two-way radio. Wherever possible, specimens were left in drawers for moving. All lab equipment, furniture and miscellaneous boxed items were moved first to allow easier access to specimen cabinets. Fixed drawer storage units and their contents were moved next. Because of the weight of the large birch units, drawers were removed, stacked on a dolly and moved separately from the cabinets. Smaller units were moved full, using a mechanical stacker, an industrial forklift fitted with a flat metal plate in place of the forks, which lifted the cabinets without tilting them.

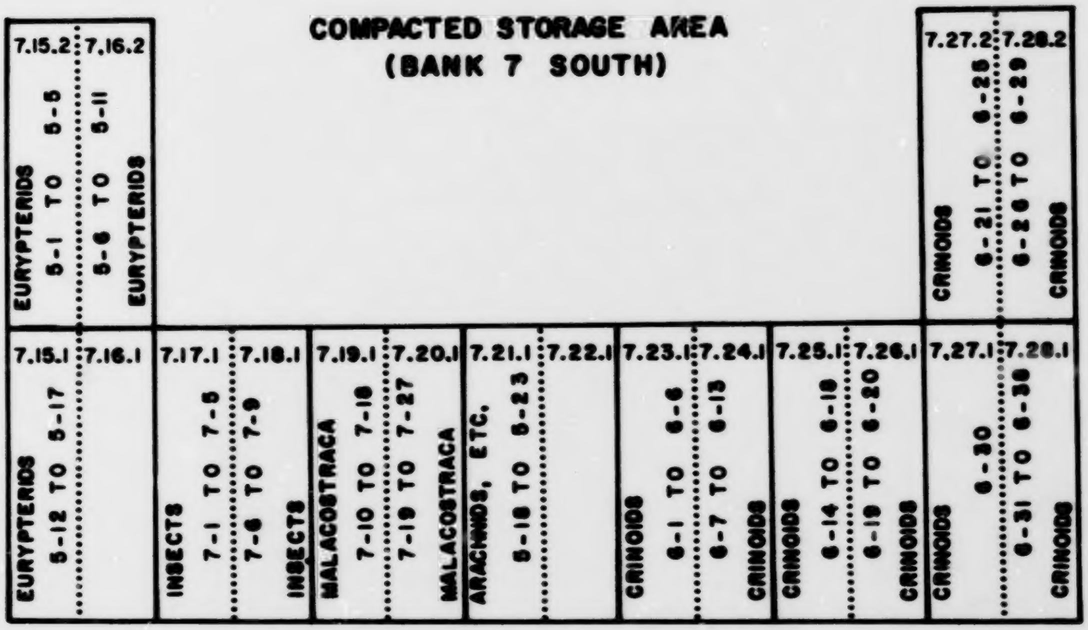
COMPACTED STORAGE AREA
(BANK 7 SOUTH)
7.15.2
EURYPTERIDS
5-1 TO 5-5
7.16.2
5-6 TO 5-11
EURYPTERIDS
7.27.2
CRINOIDS
6-21 TO 6-25
7.28.2
6-26 TO 6-29
CRINOIDS
7.15.1
EURYPTERIDS
5-12 TO 5-17
7.16.1
7.17.1
INSECTS
7-1 TO 7-5
7.18.1
7-6 TO 7-9
INSECTS
7.19.1
MALACOSTRACA
7-10 TO 7-18
7.20.1
7-19 TO 7-27
MALACOSTRACA
7.21.1
ARACHNIDS, ETC.
5-18 TO 5-23
7.22.1
7.23.1
CRINOIDS
6-1 TO 6-6
7.24.1
6-7 TO 6-13
CRINOIDS
7.25.1
CRINOIDS
6-14 TO 6-18
7.26.1
6-19 TO 6-20
CRINOIDS
7.27.1
CRINOIDS
6-30
7.28.1
6-31 TO 6-38
CRINOIDS

FIGURE 4: *Elevation diagram (facing cabinet doors) of row 7 south in the collection room showing numbering of cabinets (eg., 7.15.1) and placement of numbered drawers (eg., 5 to 5-5).*

Catalogued material in variable drawer units was rearranged considerably as it was moved. Since the drawers and cabinets were theoretically interchangeable, it was only necessary to ensure that the proper type of a cabinet was placed in each position. Initially, drawers were removed from cabinets and placed in specially designed transporter units. New cabinets in the compacted storage block were filled first (Fig. 5). The old oak cabinets thus emptied had all extraneous trim removed by carpenters working on site so that they would stack snugly and were then put in place in the stationary rows.

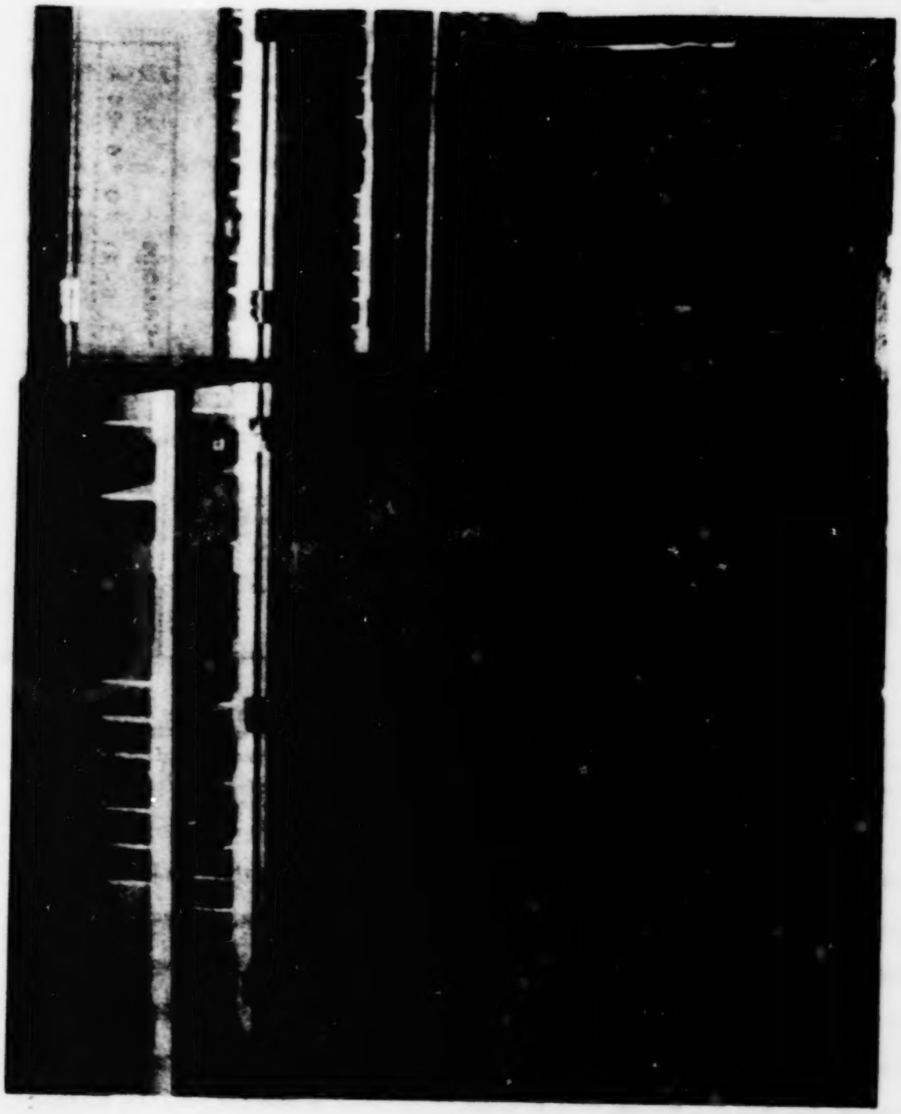

FIGURE 5: *View down an aisle in the new compacted storage area.*

The sequence of removing drawers and building up rows was carefully controlled so that the proper cabinets were in place to receive material coming in. Once space was cleared in the old collections room, the remaining cabinets were lifted down full, using the stacker, and placed on furniture dollies. The two end banks (rows 15 and 16) in the new area were built with full cabinets, using the stacker. Other rows were built by hand, with empty cabinets. By careful supervision of the placing of empty and full cabinets, it was possible to build one entire bank of full cabinets with the contents in their correct final position. In transferring the remaining drawers, nothing needed to be handled more than once. The transfer of about 320 cabinets with over 3,000 drawers of specimens took less than 3 days to accomplish.

Several factors helped simplify the move. A detailed transfer sequence for cabinets was prepared and copies were provided for all move supervisors. The sequence was adhered to as much as possible. The availability of a large number of new cabinets to move material into allowed a leap-frog sequence of moving cabinets and drawers. Much of the final transfer of drawers to their proper cabinets was accomplished over the summer thereby relieving the pressure of having to keep up with professional movers. Since the drawers designated for each cabinet were numbered, the order of this final transfer was unimportant. The only snag in this step of the move was that it turned out that not all drawers and cabinets were compatible, and some extra transferring of specimens became necessary.

The move of the ROM collections has had a number of beneficial side-effects. For the first time, the invertebrate fossils are in one area, easily accessible, clean and secure. A great deal of material which had, for years, remained virtually inaccessible can now be sorted and catalogued. The catalogued reference collection was rearranged so that major fossil groups are once more in biological order. Most groups have now been thoroughly checked for errors in filing, drawers are neatly arranged and fully labelled, and the backlog of filing catalogue cards and specimen labels is almost cleared. Material stored off-site will gradually be moved back and catalogued now that there is space to accommodate it.

Even with the preparations and upheaval involved, the bulk of the collections remained fully accessible throughout the planning and immediately up to and following the actual move. As funds permit, new cabinets will be purchased to fill the compacted storage area. With the addition of two more carriages in each block, it will be possible to increase storage capacity by about 25% with no further increase in floor area.

STORAGE OF SPECIMENS / RANGEMENT DES SPECIMENS

THE PREVENTION OF HUMIDITY-RELATED PHASE TRANSITIONS IN MINERAL SPECIMENS

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WALLER, R. 1983. The prevention of humidity-related phase transitions in mineral specimens. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 103-104.

ABSTRACT- Reactions considered are deliquescence, efflorescence and hydration. Methods for preventing these reactions in use today include: 1) coating with lacquers, 2) refrigeration, 3) storage in sealed containers at the mineral $\rightleftharpoons$ solution equilibrium relative humidity, 4) storage at the mineral $\rightleftharpoons$ lower or mineral $\rightleftharpoons$ higher hydrate equilibrium relative humidity, or 5) storage at an enforced intermediate relative humidity.

The utility of lacquers is limited by their low efficiency as vapour barriers. Refrigeration alone will at best slow reaction rates so to be effective it must be used in conjunction with another method. Storage in sealed containers at mineral $\rightleftharpoons$ solution equilibrium conditions risks morphological changes since the solution phase permits ion mobility. Storage in a sealed container at higher $\rightleftharpoons$ lower hydrate equilibrium conditions requires perfect hermetic sealing; this can be difficult to achieve in practice. Storage in a sealed container at an enforced relative humidity requires that the stability limits of a specimen be known with sufficient accuracy. This method is also limited by the accuracy with which a specific relative humidity range can be controlled.

Although problems are associated with all these methods, the last two (4 and 5) are limited only by technical difficulties and are therefore considered the most suitable for long-term preservation of specimens.

RESUME- L'auteur étudie la déliquescence, l'efflorescence et l'hydratation. Les méthodes actuelles de prévention de ces réactions sont: 1) le laquage, 2) la réfrigération, 3) l'entreposage dans des contenants hermétiques, humidité relative à l'équilibre minéral $\rightleftharpoons$ solution, 4) l'entreposage, humidité relative à l'équilibre minéral $\rightleftharpoons$ hydrate inférieur ou minéral $\rightleftharpoons$ hydrate supérieur, ou 5) l'entreposage, humidité relative intermédiaire forcée.

Les laques n'ont qu'une utilité limitée parce qu'elles ne sont pas parfaitement étanches à la vapeur. La seule réfrigération ralentit tout au plus la vitesse de réaction. Cette méthode doit donc être combinée à une autre. L'entreposage dans des contenants étanches aux conditions d'équilibre minéral $\rightleftharpoons$ solution risque d'entraîner des modifications morphologiques, car les ions peuvent se déplacer dans la solution. L'entreposage dans un contenant hermétique aux conditions d'équilibre hydrate supérieur $\rightleftharpoons$ hydrate inférieur nécessite une étanchéité parfaite parfois difficile à réaliser. L'entreposage dans un contenant hermétique à un niveau d'humidité relative forcée exige que les limites de stabilité du spécimen soient connues de façon assez précise. Cette méthode est également limitée par la précision avec laquelle l'humidité relative peut être maintenue entre certaines limites.

Bien que toutes ces méthodes présentent des problèmes, les deux dernières (4 et 5) ne comportent que des difficultés de nature technique et sont donc jugées les plus appropriées pour la préservation à long terme des spécimens.

AN INTRODUCTION TO MINICOMPUTERS IN MUSEUMS

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McALLISTER, D.E. 1983. An introduction to minicomputers in museums. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 105-136.

ABSTRACT- Minicomputers are capable of assisting with many repetitive tasks in museum collections. They permit practical utilization of the vast fund of information in museum catalogue books or on specimen labels. Data stored on computer disks may be retrieved to print labels, catalogue sheets, reports, collection statistics, answer user and outside requests about specimens, and plot distribution maps. Minicomputers are also capable of facilitating research, in performing univariate and multivariate analyses, in displaying results in histograms, X-Y graphs and dendograms. Manuscripts are readily typed and revised using text editing programs. Costs of minicomputer systems for use in managing small or moderate-sized collections range upwards from $6,000 for hardware. The cost of hardware maintenance, programs, data entry and verification must also be allowed for. The use of minicomputers in museums is presently feasible and attractive; the future is even more promising.

RESUME- Les mini-ordinateurs sont utiles pour l'accomplissement de nombreuses tâches répétitives liées aux collections de musées. Grâce à eux on peut faire usage du vaste réservoir d'information que sont les catalogues de musées ou les étiquettes de spécimens. Les données emmagasinées sur disques peuvent être rappelées pour l'impression d'étiquettes, de pages de catalogues, de rapports, de statistiques sur les collections, pour répondre aux demandes de renseignements des utilisateurs ou du public au sujet de spécimens et pour tracer des cartes de distribution. Les mini-ordinateurs facilitent également la recherche car ils peuvent effectuer des analyses univariées ou multivariées, afficher les résultats sous forme d'histogrammes, de graphiques à coordonnées X-Y et de graphiques en arbre. Les manuscrits sont tapés et révisés à l'aide des programmes de traitement de textes. Un mini-ordinateur adapté à la gestion de collections de dimensions réduites ou moyennes coûte au moins 6 000$, matériel, service, programmes, entrée et vérification des données non compris. S'il est déjà possible et avantageux d'utiliser les mini-ordinateurs au musée, l'avenir est encore plus prometteur.

DOCUMENTATION OF SPECIMENS / DOCUMENTATION DES SPECIMENS

TABLE OF CONTENTS

Page

INTRODUCTION 109

COMPUTER SYSTEMS 109

  Computer memory 110

  Storage media 111

  Computer languages 112

  Display screens 114

  Keyboards 114

  Printers 116

  Accessories 117

  Hardware costs 117

  Software 120

  Multi-user systems 122

USES OF COMPUTERS 123

  Curatorial use 123

  Text editing 125

  Research 125

  Housekeeping tasks 127

PROBLEMS 130

ADDENDUM 133

EPITOME 133

ACKNOWLEDGEMENTS 136

REFERENCES 136

DOCUMENTATION OF SPECIMENS / DOCUMENTATION DES SPECIMENS

INTRODUCTION

Minicomputer systems are rapidly becoming less expensive and more powerful. They offer great potential in accessing information stored with large and growing collections, in printing forms, in analyzing specimen data, in text-editing, and in printing address labels. To develop an adequate minicomputer cataloguing system requires capital and operating funds, your time, and person-years for entering collection data. It also requires the selection of a computer system which is capable of the tasks required and at the same time reliable; many systems are inadequate.

One should first decide whether or not to computerize. Is the collection large enough or growing rapidly enough to justify computerization? Will there be sufficient time, money and staff to start and complete the task? Is there support from the administration? Should one use a large computer or a minicomputer? Discussion of these questions is found in Chenhall (1975) and McAllister, Murphy and Morrison (1978). A National Science Foundation of the United States subcommittee recently studied the use of minicomputers for collection management and their excellent report[1] (Leviton, *et al* 1982) should be read. Also it will help to visit working museum computer installations. Alternately, perhaps the present cataloguing system with the addition of a new card file may be adequate for the collection.

In Canada, participating museums may have access to the Canadian Heritage Information Network administered by the National Museums of Canada (Ottawa, Ontario K1A 0M8). Their large mainframe computer system permits collection data from art, human history and natural history museums to be entered and retrieved on terminals at the participant's museum. Data are transmitted to and from a computer in Ottawa. Those interested should write the Director of the Canadian Heritage Information Network at the above address.

COMPUTER SYSTEMS

In order to talk to salespersons, programmers and simply understand brochures and manuals, it helps to understand the terminology of computers. Obtain a pocket book on minicomputers or a pocket computer dictionary. Take a night school course in programming minicomputers, subscribe to a magazine like *Byte* (P.O. Box 590, Martinsville, N.J. 08836; *InfoAge* (211 Consumers Road, Suite 302, Willowdale, Ontario M2J 4G8); or *Creative Computing* (39 E. Hanover Ave., Morristown, N.J.). In the following discussion basic computer terms are underlined where they are first defined.

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[1] Copies of this report may be obtained by writing Dr. Robert H. Gibbs, Jr., Division of Fishes, National Museum of Natural History, Washington, D.C. 20560, U.S.A.

Hardware is simply the mechanical and electronic equipment that you can touch while software provides the instructions that tell the computer what to do with the data. User software consists of programs. Each program is designed to perform a task (or tasks) such as: entry and storage of data, sorting of information alphabetically, and calculation of mean and standard deviations. Software may be in printed lists on paper, stored on punched cards, magnetic tape or disks, but when the software is working it consists of electrical signals in the computer. System software is the software that executes or compiles the user's programs. It includes an operating system that oversees operations, communicates with peripheral equipment like printers, searches the user's program for errors, and converts the program into machine language that computers use.

Computer Memory

Computer memory is measured in multiples of bytes (Fig. 1). A byte is a mixture of 8 ones or zeros which can represent a single character - a letter, a punctuation mark, a space or a digit, i.e., any keystroke. As an example, a number may use two, eight or sometimes more bytes of memory depending on how much precision is required. A kilobyte, often abbreviated K, is 1024 bytes (often rounded to 1000) which holds about a thousand characters or about one page of typing. A megabyte is a million bytes, a gigabyte a billion bytes.

The computer memory is used to hold and manipulate programs and data. There are two types of computer memory RWM (or RAM) which is memory the user can read from and write into memory. RWM is used for running programs or temporary storage of data. Then there is ROM, read only memory. One can employ the routines or instructions in ROM but cannot change them. Often the interpreter is the computer's own instructions which change the user's program into the machine language that the computer actually uses when running. A museum minicomputer should have about 64K bytes of RWM and ROM combined for each user; more would be an advantage in

1 BIT = SMALLEST UNIT OF MEMORY STORAGE
= 0 OR 1

8 BITS = 1 BYTE MEMORY (b)
= 1 KEYSTROKE
E.G. 00101101 = 1 BYTE ASCII CODE FOR M
00110011 = 1 BYTE ASCII CODE FOR 3

1024 BYTES = 1 KILOBYTE (Kb)
(OR 1000)

1-2 KILOBYTES = 1 PAGE OF TYPING

1,000,000 BYTES = 1 MEGABYTE (Mb)

FIGURE 1: *Memory is measured in units of bits, bytes, kilobytes, or megabytes. These are used to measure the amount of memory needed in the computer for programs or data, or the amount on permanent external storage media such as magnetic tapes or disks.*

certain tasks. Instructions remain in ROM but disappear from RWM when the computer is turned off, so permanent storage is needed for programs and data.

Storage Media

The amount of data in most museum collections far exceeds 64K bytes of memory (64 pages of data), so collection information and programs to perform different tasks must be stored elsewhere. Moreover, the contents of RWM usually disappear when the computer is turned off. Permanent storage media consist of magnetic tapes or disks. Disks resemble phonograph records (Fig. 2). Information is stored in the form of magnetic states in circular tracks on the disk surface. A disk drive and controller rotate disks and control the movement of a head which records or picks up data from the revolving disk, in a manner analogous to a record player (Fig. 2). Disks may be floppy or hard. Hard disks are more expensive but they hold more data and are more reliable because the head does not touch the disk. Some means of backing up (copying) disks is essential. Disks may be backed up onto tape, or if two disk drives are available (preferable), one disk may be copied onto another disk. It is *very important* to store one current copy of each disk in a safe place; this protects the user in case of mistakes or accidents to the disk in use. For the sake of economy, magnetic tapes can store collection data and programs but it is extremely time consuming to search from one end of the tape to another for information; tapes are more suitable for back-up storage than for retrieval purposes. Data can be located on disks in a fraction of a second. Data are stored as records in files. A collection file might, for example, have 5,000 records, each record storing the information on one collection-lot. An index file might list the collection records for each species in the collection, similar to an index card file of species.

Before purchasing a disk and computer system, calculate how much storage space is necessary. How many collection records are there and how many characters are necessary per collection record? For example, if there are 20,000 collections and it is necessary to store up to 200 bytes of data per record, one will need 20,000 x 200 = 4,000,000 bytes or 4 megabytes of permanent storage on one or more disks. There is also need for storage space for index files, temporary storage files, and housekeeping files to run a cataloguing system which might take 10-20% more disk space. And it is necessary to store programs to perform the cataloguing on the same disk drive(s). All data need not be on one disk, although this would be convenient. But the amount of data that it will be necessary to store when all records are captured affects the choice of a disk system.

Computer Languages

There are several computer languages, such as FORTRAN, BASIC and PASCAL. Most minicomputers have BASIC, some have FORTRAN; and PASCAL has become available for many. A language consists of perhaps 100 words, each of which has a precise meaning to the computer. The words, statements, commands, functions and declarations are combined in a program to instruct the computer how to perform a task. It would be advisable to choose a system with 12

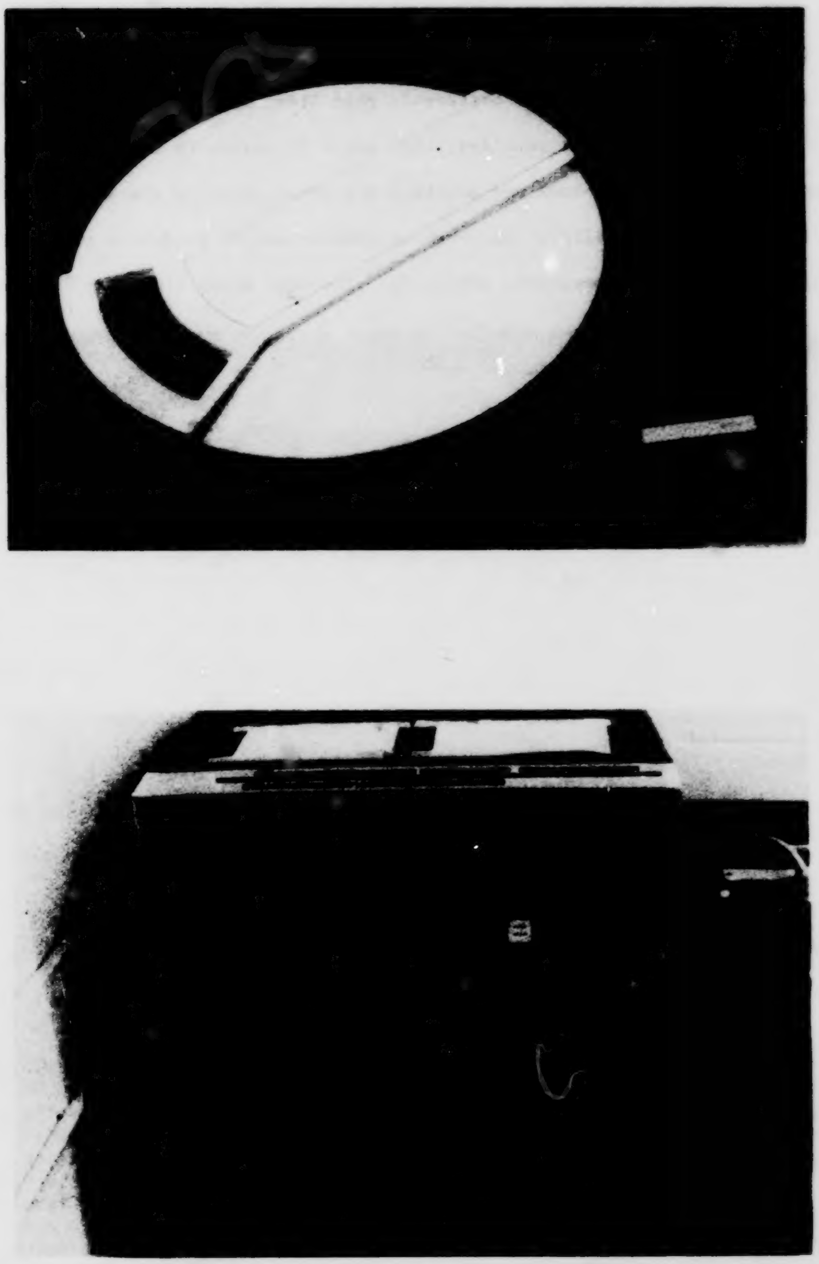

FIGURE 2: *A hard disk (above left) which holds 2 to 5 million bytes (megabytes) and a cassette (above right). Hard disk drive (below) rotates the disk, reads data from the disk and writes data onto disk. Power supply is below.*

or more digits of precision so that large numbers could be manipulated and so that reiterative computations in numerical analyses will retain sufficient accuracy. Matrices to manipulate words, short (integer) and full (double) precision numbers or save memory, are required. Generally, the larger the vocabulary of the language then the better and more powerful the language will be. It is preferable that items in the ANSI standard BASIC be included in any BASIC interpreter supplied; this makes it easier to use programs written for other computers. The more numerous and detailed the error messages the interpreter is provided with, the faster it will be to learn to program and to produce error-free programs. Some languages have 60 error messages, others 90. The more words (commands, statements etc.) a language has, generally the more powerful it is.

Display Screens

A CRT (cathode ray tube) or television-like screen which is able to display 24 or more lines of 80 characters and which has easy to read upper and lower characters will be a boon to input operators. In some systems the CRT will be located in a separate module from the computer (Fig. 3), in other cases, it will be built into the same case as the memory boards and even disk drives. Some screens display only capital letters and 32 characters in a line. The screen is used to display prompts or questions, and to show data as they are typed (entered or input). The cursor is the blinking underline or symbol which shows where the next character can be typed. Some computers offer one to seven control keys to move the cursor, and permit easy insertion and correction or data entered; these keys are very desirable. Graphic options for the CRT may be useful to analyze and display data. Colour screens are not necessary for museum cataloguing.

Keyboards

Keys on the keyboard should have a good touch, neither too firm nor too soft, should not produce double characters (debounced) when pressed, and should give a feeling that contact has been made when pressed. It is desirable to have a keyboard that permits both entry of all upper case letters without shifting during data capture, or one which can be placed in an ordinary typewriter mode with shifting for capital letters during entry of text. A numeric keypad, a separate cluster of number keys with a decimal and a comma, can speed

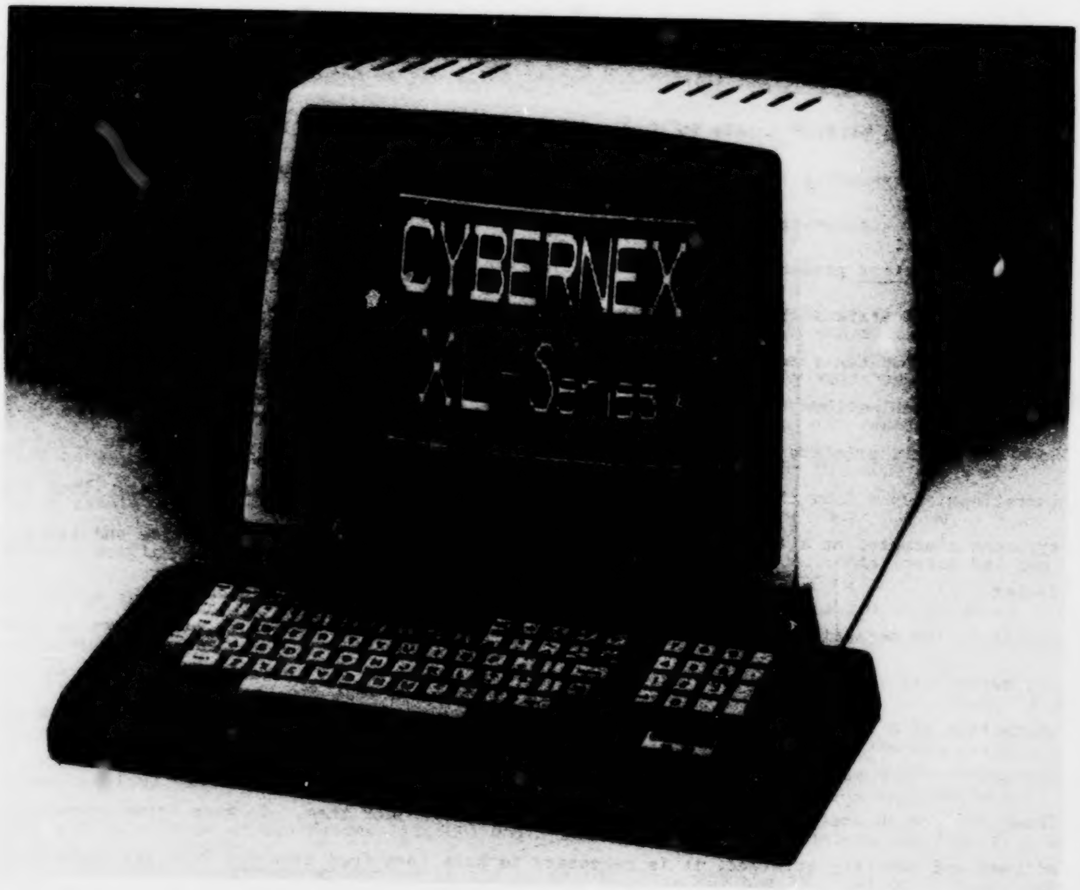

FIGURE 3: *Cybernex video terminal, a quality Canadian CRT terminal with upper and lower case, 80 characters by 25 line screen, graphic characters, line drawing, special function keys and bilingual character options available, with base price about $1300. Information available from Cybernex Limited, 2457 Dunwin Drive, Mississauga, Ontario L5L 1T1, phone (416) 828-2810.*

entry of numeric data. Special function keys are a valuable feature found on some computers. These keys can be used to store frequently used statements, words, numbers, or sometimes to call up other programs. The special function keys save typing words over again or enables the user to start a new function with a single key stroke. But above all, the keys of the keyboard should be well placed and comfortable for the operator who will have to enter hundreds of records. It is desirable for the programmer to have easy-to-use editing keys and syntax checking capability when a program line is entered, so that at least some errors are detected and can be corrected as soon as the line is entered. In many systems, errors are detected only when the program is run.

Printers

Hard copy (a printed sheet) is produced on printers. These may print ribbon ink on paper (like a typewriter) or use thermal paper which changes colour when the hot printing head touches it. Inking printers are preferable for most museum forms, though usually noisier. Character printers produce one letter at a time when a letter on a key, thimble, 'golf ball', or daisy wheel strikes the paper. Character printers are usually slow (10 to 50 characters per second), but can produce printing comparable to typewriters. Dot matrix printers form letters by combinations of wires striking the paper to produce characters formed of dots. Some dot matrix printers produce only crude upper case letters, others print letters indistinguishable from character printers. Dot matrix printers are usually faster. They may type one character at a time; others, line printers, print a whole line at a time and are even faster.

It is the mechanical parts of computer systems that are most likely to break down so look for durability in printers. How many characters are there in the character set? With 64 characters in a set there will probably be only capital letters, while with 96 or 128 characters there will be both upper and lower cases, mathematical and other useful symbols. Check for French accents if you need them, many printers lack them. To keep forms properly aligned and printing straight, it is necessary to have form feed tractors with pin feeds which pull paper using the holes along the edges of the paper. There may be 5 x 7, 9 x 9, or 18 x 9 dots in the dot matrix that forms the letters (more dots, means clearer letters). Some printers can also plot graphs. Is there a top-of-forms control which jumps to the top of new pages? Is there a need for a wide carriage, or will one handling 8½ x 11" paper (plus carrier margins) do as well? Is there a need for letter quality typing? Printers may be the slowest link in the system. If there is a large volume of work or many users, it may be necessary to buy a 200 or 400 line per minute line printer instead of a 35 character per second character printer.

Accessories

There may be other computer accessories worth considering. A plotter, with a pen on a mechanical arm, will enable one to draw graphs, maps or other illustrations (Fig. 4). A digitizer enables one to "unplot" graphs, to take x-y positional data, or measurements from graphs, photos, maps, specimens or projected images. Automatic calipers which feed measurements and a counting probe which feeds counts directly into computers are now commercially available in Canada (McAllister and Planck 1981).

Hardware Costs

Costs of several specific computers are provided as a guide for hardware purchases. Canadian prices are given. The Cromenco (TM) computers are reportedly reliable. A Cromenco Z-2H computer has 1K bytes ROM, 64K bytes RWM, two 5-inch disk drives with combined storage of 368K bytes, and an 11-megabyte hard disk. This computer system (about $15,000) has a CRT which displays upper and lower case, has special function keys costing about $3,200, and a printer costing $2,200 - $4,400 for a total cost of $20,400 to $22,400. This system has the advantage that more memory and terminals can be added to produce a system for up to seven simultaneous users.

Hewlett-Packard (TM) produces a number of quality desk top computers (Fig. 5) ranging from $5,000 upward with 32K RWM and an equivalent or more in ROM; printers and disks are extra. A Commodore (TM) CBM 8032 computer (Fig. 6) with 32K RWM, 32K ROM ($2,400) and 1 megabyte of floppy disk storage on two drives ($2,500) would cost about $4,900. Printers run from $1,250 to $4,700, for a total system cost of $6,150 to $9,600. Its CRT has 25 lines of 80 upper and lower case characters but no special function keys. A new version of this computer, the SuperPet, is now available with 96K RWM (32K user) and 36K ROM of memory and BASIC, FORTRAN, PASCAL, APL and assembler languages for $3,000, with disk drives and other accessories (as for

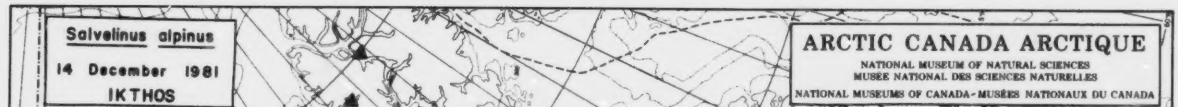
Salvelinus alpinus
14 December 1981
IKTHOS
ARCTIC CANADA ARCTIQUE
NATIONAL MUSEUM OF NATURAL SCIENCES
MUSÉE NATIONAL DES SCIENCES NATURELLES
NATIONAL MUSEUMS OF CANADA - MUSÉES NATIONAUX DU CANADA
BEAUFORT SEA
HUDSON BAY

FIGURE 4: *Distribution of the Arctic charr,* Salvelinus alpinus, *based on records in the IKTHOS minicomputer system of the National Museum of Natural Sciences, National Museums of Canada, Ottawa, described by McAllister, Murphy and Morrison (1978).*

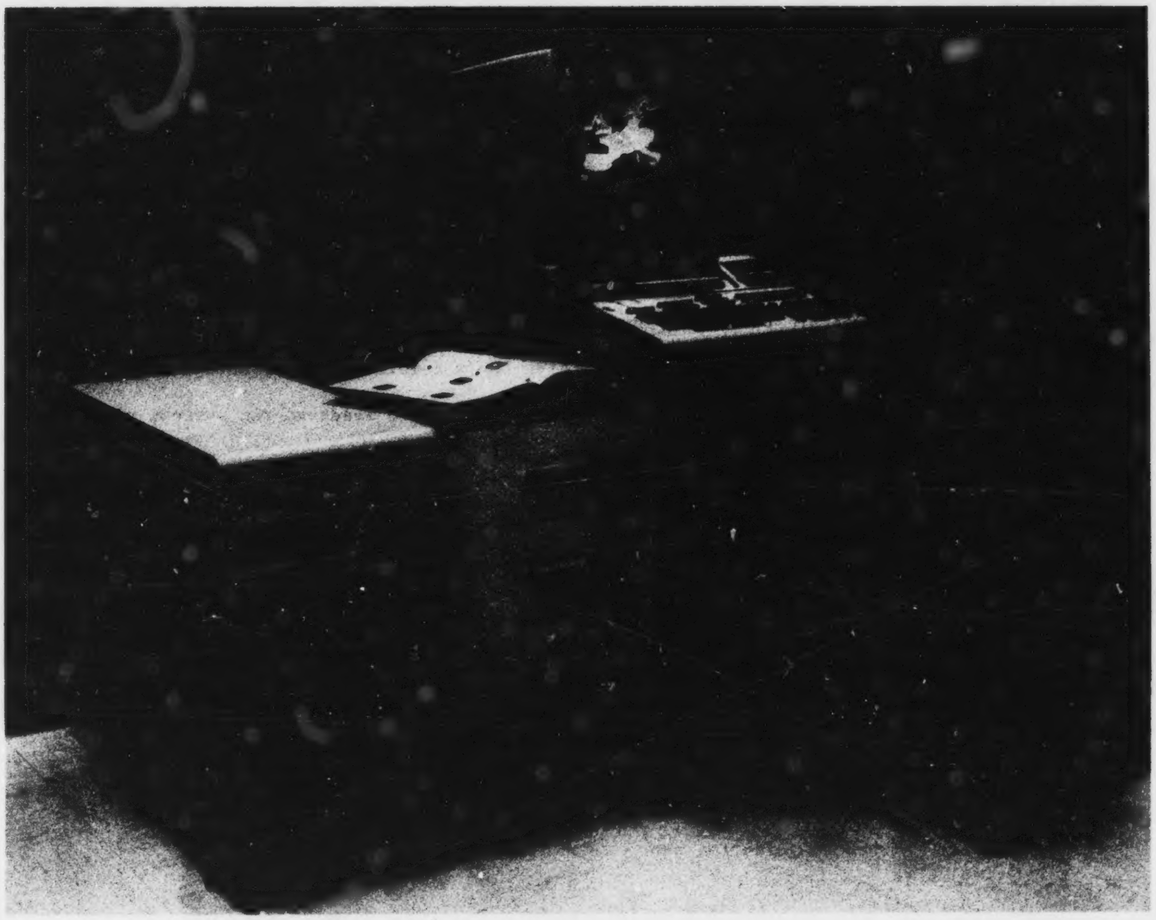

FIGURE 5: *Hewlett-Packard 945C minicomputer on desk (above) with graphics option, up to 256 kilobytes RWM, and HP7908 Winchester disk system (lower left). The disk cartridge holds 16.5 megabytes of data. The computer uses an enhanced BASIC language. Photo courtesy Hewlett-Packard, Ft. Collins, CO.*

the CBM 8032). The SuperPet's BASIC is good with 115 statements, commands etc. The SuperPet is designed to communicate with large computers, and a word processing program with French as an option, is available.

Several systems with 16 bit central processing units (CPU), instead of 8 bit CPUs, have just appeared on the market. The basic Wicat System 150 for single users (Fig. 7) starts at about $7,000 for 128K bytes of memory, two 160K byte 5¼ inch floppy disk drives, two RS-232C ports or socket outlets, one parallel port and one language; to this add the cost of a printer. Wicat 150 systems may have up to one megabyte of user memory, 10 megabytes of hard disk storage and 4 users. The IBM personal computer costs about the same for a similar configuration but has a lower maximum user's memory and cannot be configured for more than one user. Both systems have detachable keyboards. These two systems, the first of a new generation, have considerable promise.[1]

I owned a Radio Shack (TM) TRS-80 Model 1 with full 48K byte RWM memory and 2 floppy disk drives. It proved to be unreliable and I sold it at a considerable loss.

In purchasing hardware it is worth paying 10-30% more for a reliable computer. When the computer is not working, it is a wasted investment and a source of frustration. Speak to other computer owners before purchasing one; join a local computer club. Some computer sales persons are knowledgeable and honest. Alternately, buy a complete system, hardware and software, from a company that sells turn key systems, which are ready-to-run systems with hardware and customized software.

Software

Software is needed to perform your cataloguing functions. Software should help with the entry of data, perform checks on that data, store the data in permanent files, set up an index, with for example, species, province (state), country, etc., build a master file, permit retrieval of the data, print labels and catalogue sheets, permit collection records to be corrected and deleted, as well as other tasks. It should be easy to use with prompts displayed on the screen to guide the user at each step.

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[1] See two newer systems in the ADDENDUM at the end of the paper.

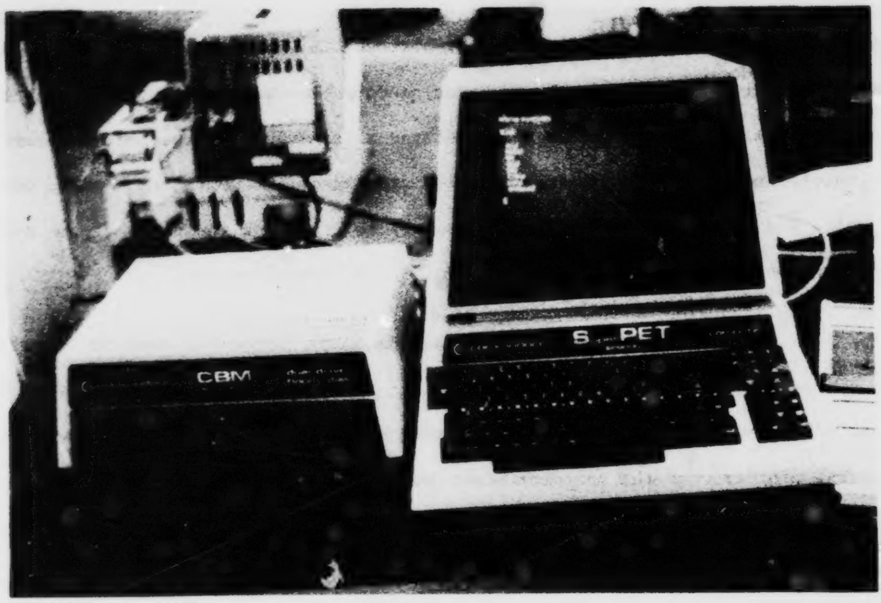


FIGURE 6: *Commodore SuperPet minicomputer with dual floppy disk drive (stores almost one megabyte). Supplied with BASIC, PASCAL, FORTRAN, APL, and assembler languages and manuals, 32 kilobytes of user RWM memory, 64 kilobytes system RWM and 36 kilobytes of ROM. SuperPet and disk system costs about $5,400; printer extra. Word processor program an option.*

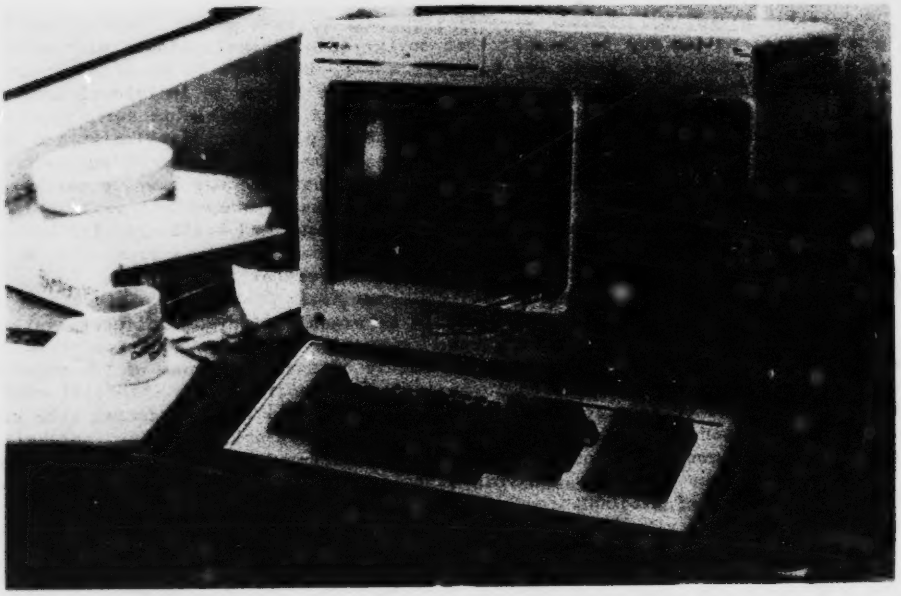


FIGURE 7: *Wicat 150WS single user minicomputer with one floppy disk and ten megabyte hard disk drive, and 384 kilobytes of RWM costs about $12,700; printer extra. Can be expanded to serve four users. Detachable keyboard increases user comfort.*

Software may be written to your specifications. Our cataloguing software cost was $6,000 five years ago. Alternately an existing data base management system (DBMS) might be adapted to one's needs. A DBMS is a generalized information storage and retrieval system that can be adapted to the user's needs. Examples are Image (TM Hewlett-Packard); Cromix (TM Cromenco); and dBase II. It is first necessary to establish the needs of the system before determining whether an existing DBMS will fulfill all requirements.

Multi-user Systems

Some minicomputer systems can serve several users simultaneously. With time-sharing the central processor of the computer might be operating at one-half million, one million or more instructions per second. Each user is given access, when needed, to some of these instructions. Each user has her/his own terminal and individual output devices such as a printer, or may share a highspeed printer and large hard disk drives. To the individual user the system appears to be responding promptly to her/his instructions and programs. Individual programs and files may be protected from use by others with passwords. Alternately, such a computer may also permit multi-tasking. Under multi-tasking a computer can for example be simultaneously printing a manuscript and performing a statistical analysis for the same user.

A multi-user system *may* be cheaper than buying several small single user systems, it may be more powerful in computing speed, and it *may* be larger in individual user (RWM) memory work space. The costs of high speed printers, plotters, digitizers, and large disks can be shared in a multi-user system. On the other hand, one may have to purchase expensive communication equipment to connect users in distant rooms and buildings, its system software is more expensive, and a part or full-time computer operator is required.

Where there are several potential users in an organization,a multi-user system deserves investigation. Because of the considerable outlay of funds, because of the possible variety of requirements, and because some single user systems offer more potential than some multi-user systems, such consideration deserves careful and knowledgeable study. Most multi-user systems cost upwards of $15,000.

Systems that might be considered include an Alphamicro (at least 17 terminals), the DEC PDP 11/34 (2 up to 24 terminals), the new DEC PDP 11/24, the Hewlett-Packard 1000 series of minicomputers, the Wicat 150 (up to 4 terminals), the Wicat 100 (up to 96), and the Proteus (see Addendum) with 2 users per unit, up to 256 of which may be linked together (for a total of 512 users).

A network of small computers like the Proteus, or the Hyperion (see Addendum) linked together has advantages over a large multi-user computer. Response to the network system does not deteriorate as more users are added. When a big system breaks down no-one can compute, whereas it is unlikely that more than one unit of a network will be down at any given time.

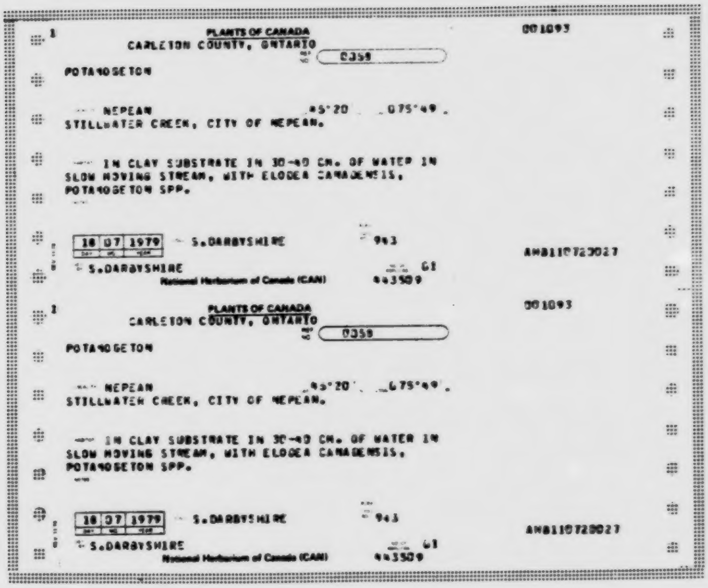
USES OF COMPUTERS

Computers may be used in several areas of museum work, including curatorial work, manuscript and letter writing, research and housekeeping tasks. Uses in administration (payrolls, personal records) and in displays (security, climatic and electronic display controls, museum library ordering and information retrieval, or interactive information terminals with the public such as Telidon) will not be discussed here, although they offer great potential.

Curatorial Use

Computer systems may be used to store, for example, species, geographic, collection, ecological and other data that are recorded with collections. These data with appropriate programs may be retrieved in the form of labels, catalogue sheets, species, localities, habitats, lists of numbers of specimens from a given or all areas, and lists of specimens available for a species or a family. A computer-printed herbarium label is shown in Fig. 8. Complex questions may be asked, such as: "In which months and in which counties of Ontario are *Elymus virginicus* found?" Once data are stored in the appropriate manner, the limitations on the use of such information will be a matter of funding. With our system, preparation of graphic summaries of depth and temperature distribution is quite feasible, but there are insufficient funds to pursue the work. Nevertheless, the data for complex collection data retrieval can nevertheless be listed or counted with our present system.

Computerization can aid collection management. Accurate answers on how many collections, specimens and species there are, can be more easily provided. One can easily reply to enquiries on the availability of specimens of particular taxa. Poorly collected regions can be located and given priority for future research. We have not computerized our loan system but this could easily be done.



1 PLANTS OF CANADA 001093
CARLETON COUNTY, ONTARIO
0359
POTAMOGETON

NEPEAN 45°20' 075°49'.
STILLWATER CREEK, CITY OF NEPEAN.

IN CLAY SUBSTRATE IN 30-40 CM. OF WATER IN
SLOW MOVING STREAM, WITH ELODEA CANADENSIS,
POTAMOGETON SPP.

DAY	MO	YEAR
18	07	1979

S.DARBYSHIRE 943
AM8110720027
S.DARBYSHIRE 61
National Herbarium of Canada (CAN) 443509

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CARLETON COUNTY, ONTARIO
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DAY	MO	YEAR
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S.DARBYSHIRE 943
AM8110720027
S.DARBYSHIRE 61
National Herbarium of Canada (CAN) 443509

FIGURE 8: *Herbarium label printed by computer for the National Herbarium of Canada, National Museums of Canada, Ottawa. Multiple copies permit labelling replicas with no extra manual effort.*

Text Editing

Most curators write manuscripts and reports which are traditionally retyped several times as drafts are modified. Text editing programs are available for most minicomputers. With a text editor, only those sections of the text which require changing or expansion are retyped into the computer. In current usage, word processing is generally applied to more sophisticated text-editors. Commands permit deleting and sometimes moving blocks of text, specifying line length, underlining, spacing of text, numbering of pages, and many other features. If your computer is not continuously used for collections, seriously consider purchase of a word processing program for manuscripts. Speak to a program user before you buy. Some programs can handle French accents, if you have a compatible printer. Look for capacity to handle subscripts and superscripts if there is a need for footnotes, formulae, etc.

Research

There are many possible uses of computers in museum research. Maps of distribution may be produced from collection records, if latitude and longitude are recorded and a plotter or a plotter-printer is available. Geographic, ecological and other stored collection data may be retrieved.

However, for special research projects the user may wish to study data not ordinarily stored in collection records. For example, measurements, counts, colour, shape could be recorded for a particular taxonomic project, typed into the computer and stored on disk for analysis. These stored data could then be depicted in histograms or X-Y plots, and means and standard deviations could be calculated. Differences could be evaluated using univariate tests such as Student's T-test, F-test and Chi-square test. Multivariate tests such as principal components analysis (Fig. 9) and discriminant function analysis, too long and complicated for ordinary manual calculation, are easily run on the better minicomputers able to compute in double precision. These programs, and others, are frequently used in our minicomputers for ichthyology, mammalogy, herpetology and paleontology.

One advantage in computerizing statistical tests is that the data need only be entered, checked and stored once, but then can be subjected to several tests. Additional data can be added to the original file and the tests rerun with little additional effort.

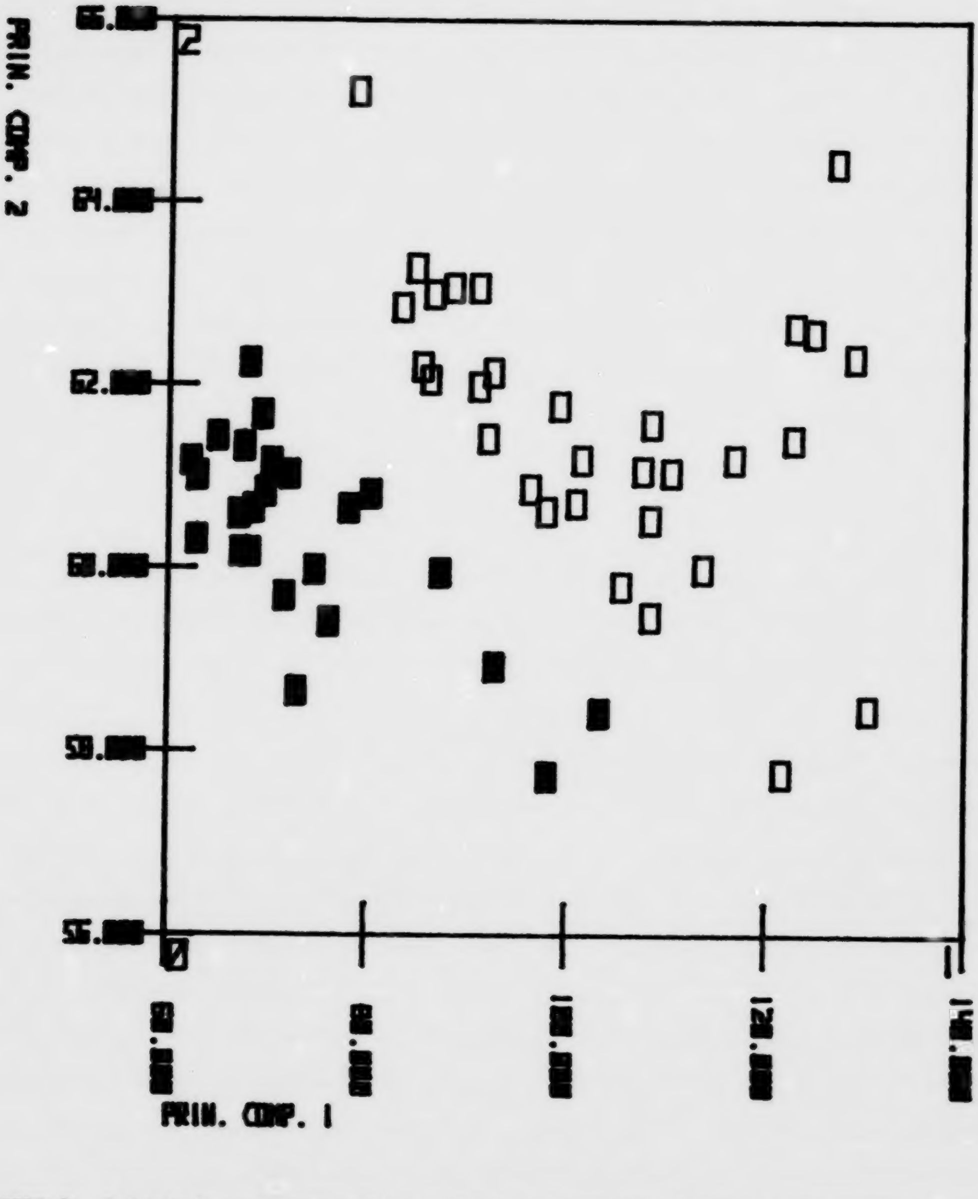


FIGURE 9: *Principal components analysis showing separation of two sibling species of smelts performed on a computer and illustrated with a plotter. No one character separated all specimens, but the analysis, by combining several characters, permits complete separation. Multivariate analyses like this are very difficult to calculate by hand, but are easy with a computer, once a program is available. Computers with double precision matrices are required.*

Computers can even assist in the collection of specimen data. McAllister and Planck (1981) described calipers (Fig. 10) for measuring and a probe for counting, interfaced to a computer. A portable model attached to a programmable pocket calculator is available. Automatic calipers at least halved the time to measure, record and store data. With this system, measurements are displayed on the CRT, printed in a table on the printer and stored on tape cassettes. Errors in reading handwritten records and entering data were avoided. (A commercial version is now available from Limnoterra, 275 Lancaster Avenue West, Kitchener, Ontario N2H 4V2, (519) 579-3860).

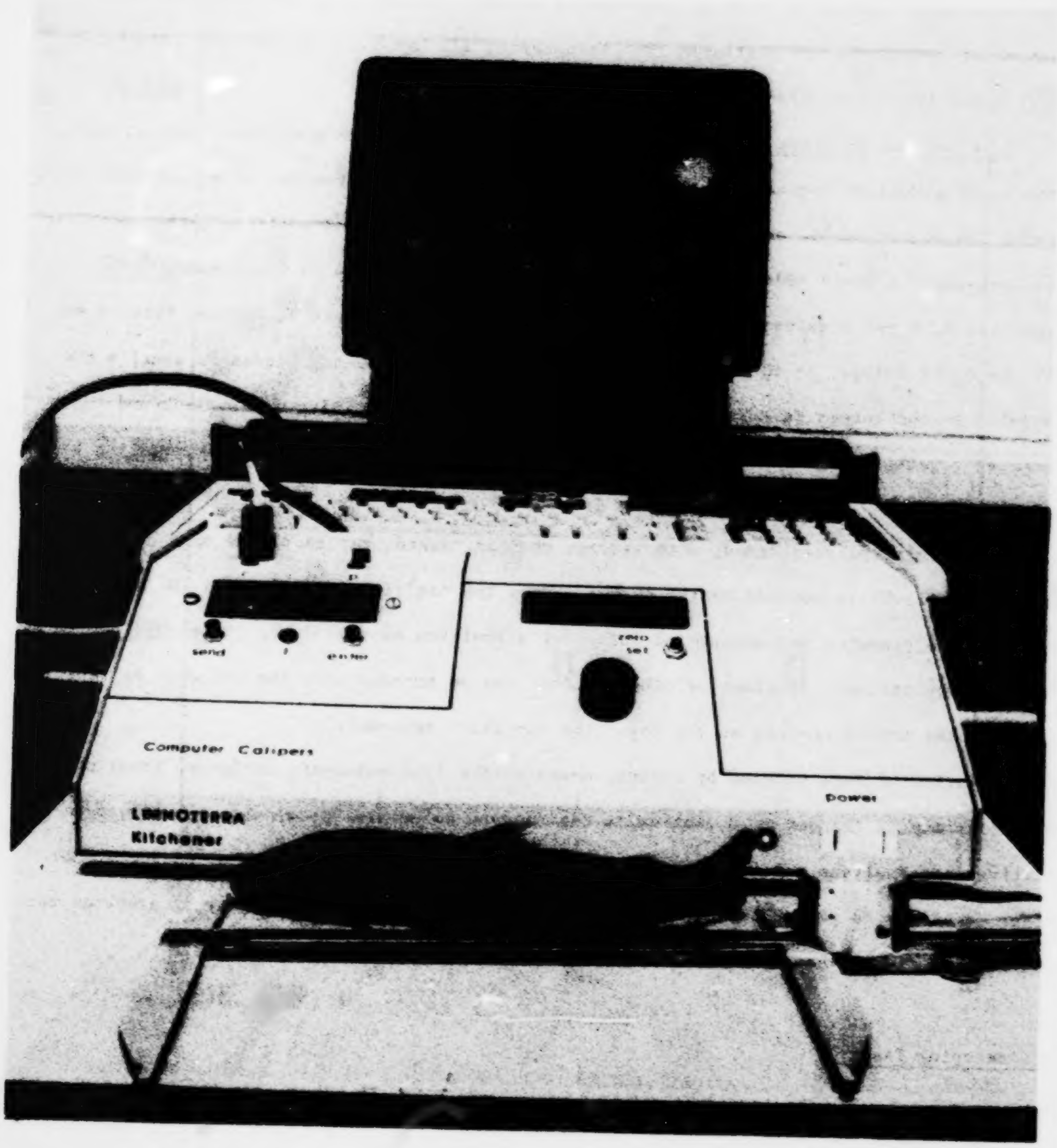
Digitizers or graphics tablets are electronic boards on which specimens, photos, maps, graphs are placed or images projected. A cursor or a stylus is touched at appropriate places around the object/image, and a button pressed. This sends X and Y position measurements to the computer. A sonic model is available that takes measurements in three dimensions, supplying X, Y and Z values (Megatronix, Inc., 100 Penn Drive, Unit 1, Weston, Ontario M9L 2A9, (416)742-8015). In the stream mode, an entire series of measurements is sent to the computer as the cursor is moved around the edge of an object. Using a digitizer and the computer together, measurements, positions, angles, shapes, areas and other values can be calculated.

Alternately, printed forms, with various choices marked, may be placed on a digitizer. The chosen items are touched by the stylus. From the digitizer position and the controlling program, the computer can accept and interpret a position as one of the choices on the form. Thus, survey records, specimen or other records can be entered into the computer by rapidly touching the ticked choices on the form (the so-called menu-mode).

Summaries of data entered by keying, measurements from automatic calipers, probe or digitizer may be graphed on a plotter in one or more colours. The results of univariate or multivariate analyses may be illustrated. Various dendrograms, phenograms, cladograms or other trees may be plotted to visualize relationships. Finished graphs may be prepared for publication, i.e., the distribution symbols in Fig. 4 were drawn by a plotter.

Housekeeping Tasks

Under "housekeeping" I include a number of odd but repetitive jobs that most curators must do. Although these take considerable time manually, they require very little user time on a computer.


send
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zero
set
Computer Calipers
LIMNOTERRA
Kitchener
Power

FIGURE 10: *Automatic calipers interfaced to a computer (or a pocket programmable calculator) permit rapid measurement of specimens.*

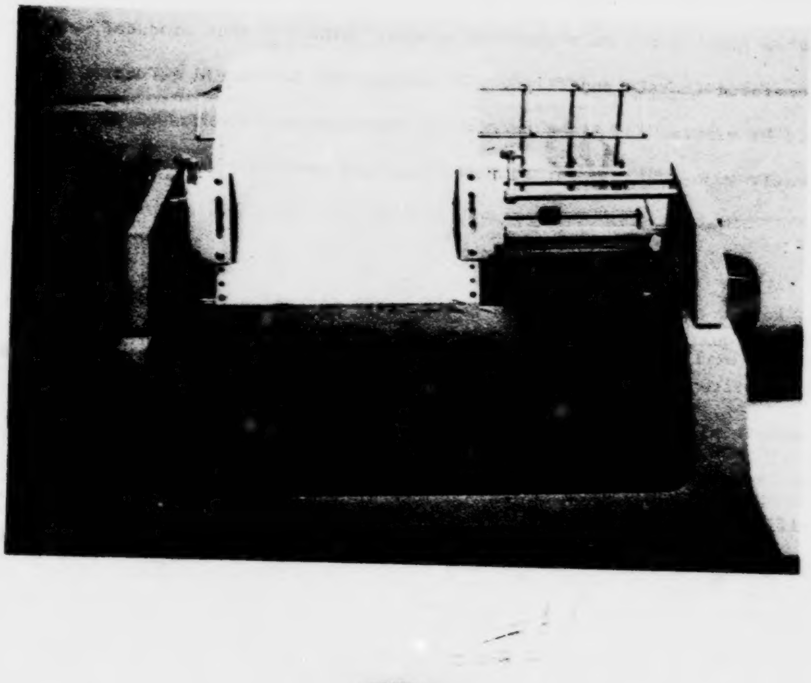

FIGURE 11: *A character printer (above) which produces letter quality typing using a daisy-wheel (below). Individual letters are struck against the ribbon as the wheel spins and produce the printed letters at 35 characters per second.*

Two or three times a year reprints are mailed to about 350 colleagues around the world. To address the envelopes on a typewriter takes 2 - 3 hours. Our mailing list was typed into the computer once, now 10 minutes is spent updating the list, mounting labels (supplied on a continuous wax paper carrier) and the computer prints address labels unattended. A character printer is shown in Fig. 11. Labels are peeled from the carrier and pressed onto envelopes.

References and reprints are maintained in author and subject files (7.6 x 12.7 cm library cards). An operator types into the computer the citation once with one or several subjects. When a batch of reprints has been entered in this fashion, an author card and one card for each subject is printed for each reprint; several cards are thus produced. The perforated cards are separated (*burst*) and filed. Of course, the data could be stored on disk files. Letters could be written and filed on disk in the same way; the museum of the future will probably greatly reduce the amount of paper used and stored.

PROBLEMS

Purchasing a quality system will reduce the number of repairs and make it easier for programmers to write software. Before you decide on the hardware that is needed and can be afforded, explain all the requirements to both a *system analyst* (a person who designs the overall computer system) and a *programmer* (a person who writes individual programs under system specifications).

Software should be quickly tested with different kinds of data that will be input. Forms should be carefully checked for spacing. When a moderate number of records have been entered, the data base should be queried and different reports requested. The capacity to correct, delete, and add records should be verified. Does the system help the operator sufficiently to perform the various tasks with prompts on the screen? Is it easy to use? After a period of *debugging* (correcting flaws in the programs), the system should run smoothly. But sometimes, problems with different data, or an unforeseen problem, will appear and have to be corrected.

Computer hardware is commonly guaranteed for 90 days, although some like Innovative Electronic Technology's Proteus computer are guaranteed for a full year. Use new equipment as frequently as possible during this period. If regularly used, problems with computer circuitry and memory are most likely to appear at this time while the computer is still under guarantee. Accessories with moving parts, such as printers and disks, are more likely to fail than purely electronic devices. It may be worthwhile purchasing preventative maintenance (PM) contracts on printers and disks. In any case a budget should include money either for PM contracts or repairs. It is desirable to purchase computer systems from companies that provide local repair services.

Copies of computer disks should be made periodically. It is suggested that three copies be kept, the current, parent and grandparent copies. The current disk should be backed up onto the grandparent disk once a day or week, depending on how easy it is and how willing you are to re-enter a day's or a week's work. The current disk then becomes the parent and the grandfather becomes the current disk. Backups may be needed in case of a crash where the drive misfunctions and destroys data, where the software has not been fully debugged, or where the operator has performed incorrect procedures. I also keep a set of museum disks at home in case of fire. Backing up provides easy protection from disaster, you may never need it, but if you do you'll be very glad months of hard work were not lost. We have used backup disks about half a dozen times in six years with a hard disk system (more reliable than most floppy disk drives).

Printers periodically print gibberish (Fig. 12). The ribbon may leap behind the printing wheel head leaving you with several pages of blank paper, or the paper feed mechanism may misfeed resulting in a jam and 500 lines printed on one very black line! Once an inking roll loaded with black ink burst, painting the landscape black. Our software and mechanical probems result in two to four weeks loss of time per year. Some computer companies publish MTBF (mean time between failure rates) for their equipment. WIÇAT Systems advertises a MTBF of approximately 3,000 operation hours for their model 150; many companies do not advertise this figure, but will supply it on demand. Try to obtain these figures and compare them before purchase.

Another problem is finding and keeping staff with the talent for carefully inputting and verifying data. (Data should always be verified; instant access to garbage is not progress). This requires responsible and careful persons, who should be made to feel the value of their work. A variety of tasks makes the work more interesting for an operator. Most of my input operators have had biological backgrounds and have been given on-the-job training with computers, but I've also given biological training to computer operators with satisfactory results. Keeping an up-to-date instruction manual with simple detailed instructions for each task is a help in training operators - and for yourself or colleagues. One of the operator's tasks should be to keep it current and to clarify difficult sections. Once the system is launched into orbit, the operator is the most important person for the success of the system. Glare-free screens with clearly displayed bright letters, detachable keyboards, low sound levels from printer and disk drives, table or desk at the correct height, and a comfortable chair will make the task of data entry much more pleasant, and free the operator from problems of tired back, shoulders or neck that otherwise may appear. There have been reports in the press recently of persons operating video terminals and having health problems. The radiation emissions were measured on our two computers and they were found to be negligible from the point of view of known health hazards.

A final problem results when your analytical programs are debugged and successfully flying- your colleagues who formerly scorned computerization will be asking, "I wonder if I could have a little time Thursday morning.........!"

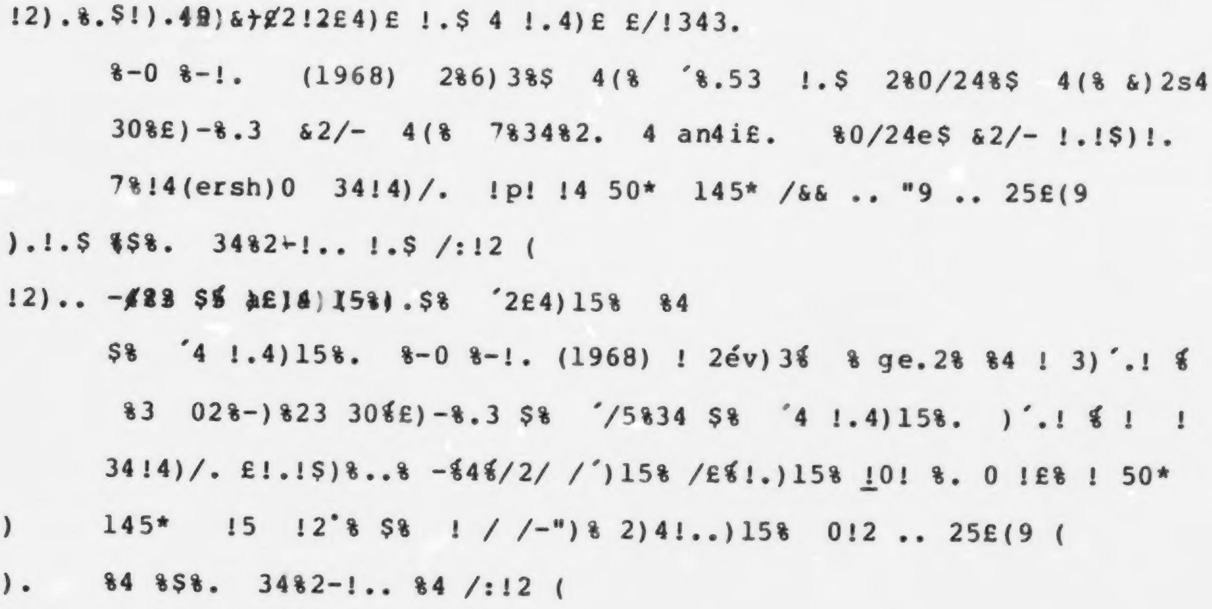

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FIGURE 12: *Computer systems are not trouble free. This gibberish resulted from bad contacts on the cable linking the computer to the printer.*

DOCUMENTATION OF SPECIMENS / DOCUMENTATION DES SPECIMENS

ADDENDUM

This addendum permits us to present information on two promising new compact but powerful 16-bit processor systems which are quality computing machines made in Canada.

The basic two-user Proteus has 128K bytes data; and systems, CP/M, and BASIC software with a UNIX-like (TM) BITOS operating system (Figure 13). It measures only 15 x 15 x 20 cm. This basic system costs $6100; to it should be added one printer and two video terminals (one terminal/user). RWM can be expanded to 768K bytes. Up to 256 Proteus modules can be linked into a network. Winchester hard disk drives or 8 inch floppy drives may be added. More information may be obtained from Innovative Electronic Technology Ltd., P.O. Box 5188, Vancouver, B.C. V6B 4B3, phone (603) 430-5166.

With the Hyperion's ergonomically designed package is included a 16-bit processor, 256K bytes of RWM, 28K bytes ROM, 640K bytes of storage on two very quiet floppy disk drives, a non-glare CRT with high resolution graphics, a built-in modem, a battery powered clock, advanced BASIC interpreter, an electronic Visicalc-like (TM) spreadsheet, a text editor and an electronic mail package (Figure 14). Compatibility with the IBM Personal Computer makes much software and hardware immediately available, yet Dynalogic's design has many advantages over that computer. A 10 megabyte hard disk, a BASIC compiler, FORTRAN, PASCAL, and COBOL will soon be available. Hyperions are designed to easily communicate with one another or other computers over the phone line. More information is available from Dynalogic Info-Tech Corporation, 8 Colonnade Road, Ottawa, Ontario K2E 7M6, phone (613) 226-7013.

EPITOME

Due in part to limited budget and staff we have explored only part of the potential of our machines. The limits of application are to a large degree the result of the imagination, persistance, priority and time that one wishes to devote.

The trend towards lowered cost of computers and accessories, and new developments will make many creative ideas practical in coming years.

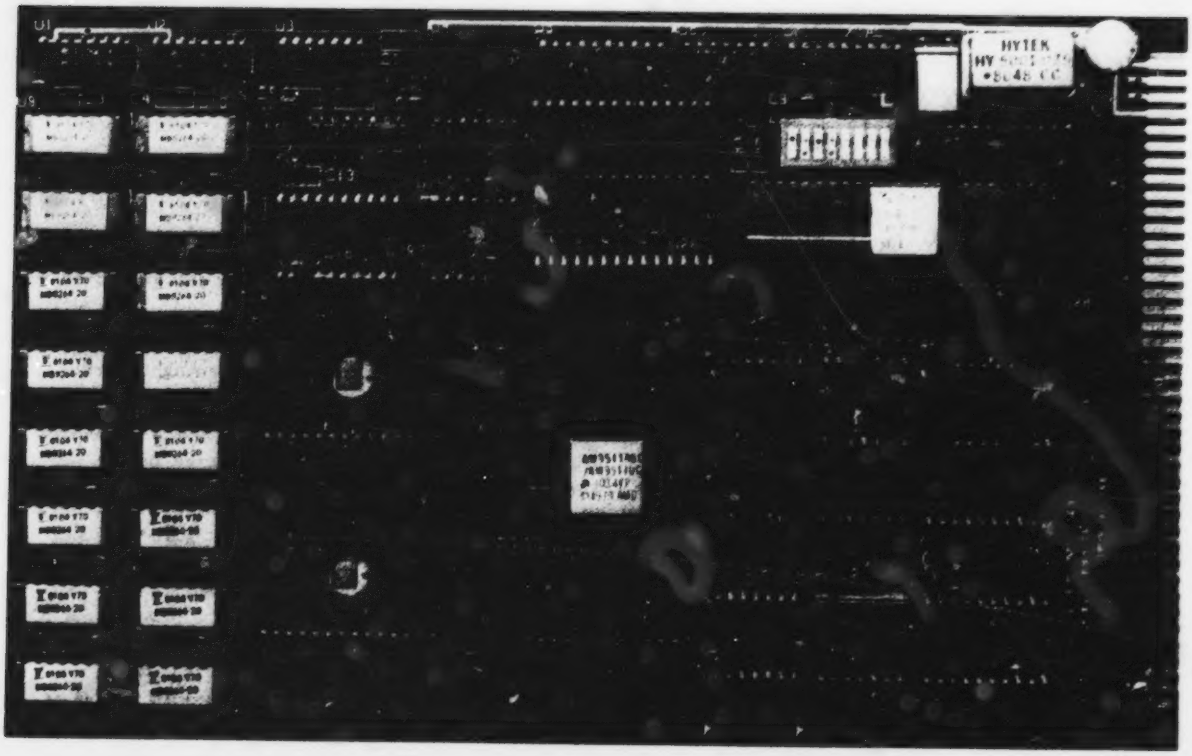

FIGURE 13: *The CPU board of a recently released 16-bit processor Proteus minicomputer showing the LSI (large scale integration) memory chips.*

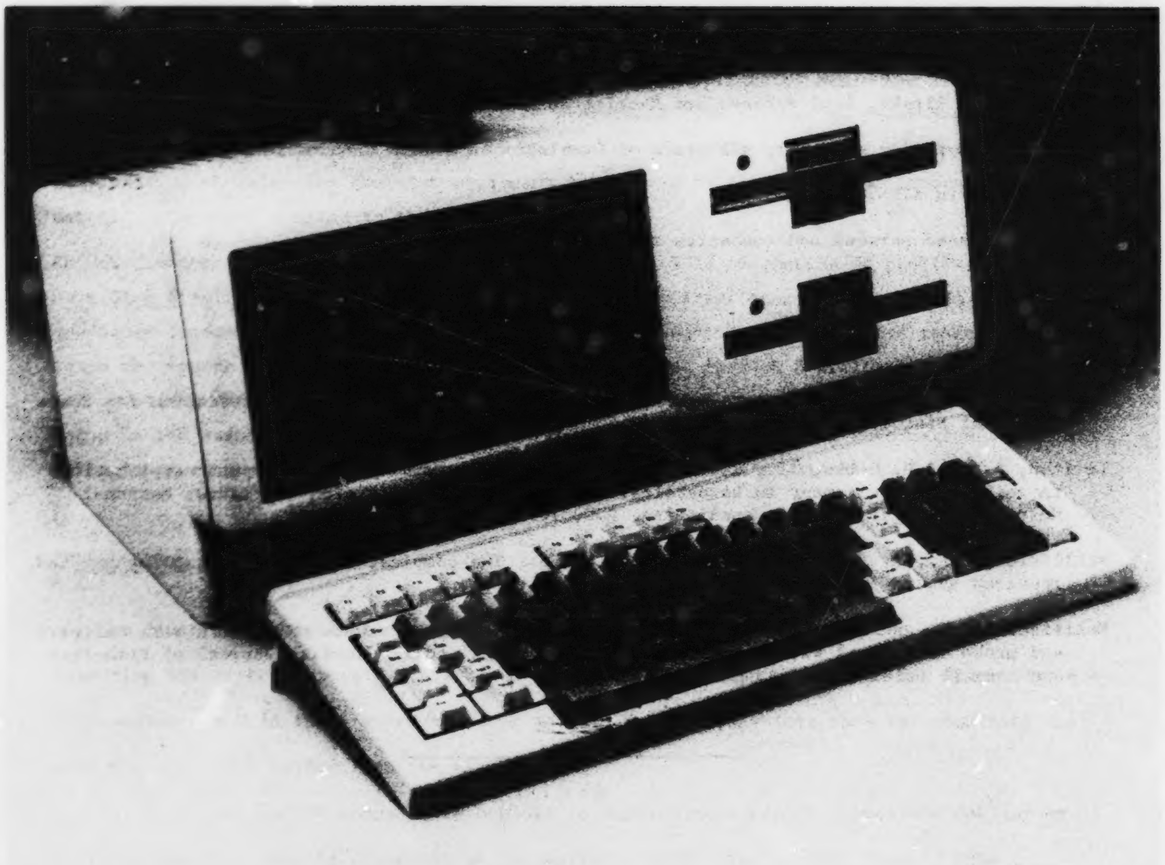

FIGURE 14: *The Hyperion minicomputer, released January 1983, is well-designed, compact (less than 10 kg), yet powerful. Everything needed, keyboard, memory, screen, disks and software are included in the package (except for a printer) for $6995; a model with fewer features costs $4895. The Hyperion is easily connected over the phone, which simply plugs into a socket in the back, to another Hyperion or other computers. The modem needed for communication is built into the package. Built-in help and explain functions assist beginners to learn or remember commands and their uses by pressing labelled keys.*

ACKNOWLEDGEMENTS

Drs. F.W. Schueler and D.J. Faber kindly criticized this manuscript. Compumart, 411 Roosevelt Avenue, Ottawa and N. S. N. Options Ltd., 1680 Woodward Drive, Ottawa K2C 3R8, kindly permitted photographs to be taken of their equipment. A photograph of the Cybernex CRT was obtained from Cybernex Ltd., 2457 Durwin Drive, Mississauga, Ontario L5L 1T1 and one of the HP 9845 computer system was obtained through the courtesy of Sue Kolb and Douglas Blackwood, Hewlett-Packard, Ft. Collins, CO. A photograph of the just-released Proteus 16-bit CPU minicomputer was obtained through the generosity of Dr. Y.T. Kim, President, Innovative Electronics Technology Ltd., P.O. Box 5188, Vancouver, B.C. V6B 4B3. Donna Dunning, Anne Dunn, William Lipski, Paul Mathews and Maurice Jolicoeur demonstrated and provided photos and data on the Hyperion computer, all staff of Dynalogic Info-Tech Corporation, 8 Colonnade Road, Ottawa, Ontario K2E 7M6.

To all these persons and companies the author is very grateful.

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DATA PROCESSING APPLICATIONS: THE RIGHT MACHINE FOR THE RIGHT JOB

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National Inventory Programme, National Museums of Canada, Ottawa, Ont. K1A 0M8

HOMULOS, P. 1983. Data processing applications: the right machine for the right job. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 137-140.

ABSTRACT- The type of computer equipment needed to solve any particular problem must be determined by a careful analysis of the characteristics of the problem to be solved. Two fundamental questions which have to be asked about the application are: how fast must the computer respond and how much data is to be processed? The answers to these questions translate into the speed and capacity of the equipment. This is a gross simplification of the complexities of selecting computer equipment but serves to illustrate the importance of matching the right machine to the application.

RESUME- Le type d'installation informatique convenant à la résolution de problèmes précis doit être établi après une analyse soigneuse des caractéristiques de ces problèmes. Deux questions fondamentales au sujet de l'application informatique doivent être posées : de quel temps de réponse a-t-on besoin et quel est le volume des données à traiter? Les réponses à ces questions déterminent les caractéristiques du matériel nécessaire. C'est peut-être une façon un peu simpliste d'exposer la complexité du choix d'un matériel informatique, mais qui illustre pourtant bien l'importance d'accorder la machine à l'application.

INTRODUCTION

The electronics revolution of the 1970's has dramatically increased the complexity of selecting the right computer. In 1980 at the West Coast Computer Fair in San Francisco, over 500 companies showed their micro-computer wares. Each company felt they had something that made their product better than the next.

The speed with which computer technology is developing makes it impossible for anyone to be fully aware of what is presently on the market. With this in mind, I would like to describe several different computer applications and suggest the general type of machine best suited for them.

SPEED AND CAPACITY

Consider data processing applications in terms of speed and capacity. The speed component refers to the speed with which the computer does a particular operation and the capacity component refers to the computer's capacity to store information and to transmit that information from one unit of the computer to another.

If you ask two different computers to add two numbers, they will each do it in a different time. This can be thought of as asking two people to add the same group of numbers. There will always be a difference. A computer does one operation at a time. The time it takes to perform the simplest operation is known as the cycle time of the computer and this time varies from computer to computer. The second component of speed is how much data the computer can "read" at one time. When you want to use data stored on a computer disk for a mathematical calculation, as an example, the computer reads it from the disk. Some computers read that data one character at a time, while others read many characters at a time. Obviously, it is faster to read large groups of data at one time rather than read small parts of it.

The capacity of the computer to store data is determined by the capacity of its disks and the number of disks you can plug into the computer. For example, many micro-computers will only allow you to plug in two floppy disks each with a capacity of 1 million characters (each letter of the alphabet or single digit number is a character), therefore they would have a storage capacity of 2 million characters. A large computer may allow 50 disks of 800 million characters each or a capacity of 40 billion characters.

Computers have the ability to record and store data on some type of magnetic medium like a computer tape or disk. These data are recorded and held much like audio signals are held on an audio tape. A computer tape forces you to locate data sequentially much like an audio tape, while a computer disk allows you to go directly and quickly to the data in the same way a record allows you to move to a particular song.

Computer Applications

Lets look at a few applications in terms of their needs for speed and capacity.
Scientific: Scientific and statistical applications generally have very complicated mathematical calculations to perform. In some cases, such as with meteorological work, they

also have vast volumes of data. In others, such as economic forecasting, data volumes can be fairly low. In most cases, because of the complexity of the calculations, this application requires a great deal of speed from the computer.

Word Processing: Word processing machines are used to produce letters, reports, manuscripts, etc., but not to print books, store files or retrieve large volumes of text. Word Processing is an application for which the speed requirement is determined by the typist and the capacity by the length of the typed document. The world's best typist is slow compared to the world's slowest computers. Word Processing is therefore an application which requires neither great speed nor capacity from the computer.

Libraries: Applications in libraries typically have large volumes of text and are expected to locate specific items in the book collection. The location of these items is usually a fairly simple task, but the computer must search a larger number of records to select those required. A library application is therefore one that requires great capacity but not much speed.

Business: Applications for business generally do not have large volumes of data or complex manipulation of data. A small retail operation has a payroll, accounts receivable, accounts payable, and inventory control. They do not require great speed or capacity. On the other hand, a large manufacturing organization has all of the above in addition to sales forecasting, computer assisted design and manufacturing work, scheduling, etc. The requirement for speed and capacity is therefore usually determined by the size of the organization and the number of different uses for the computer within that organization.

TYPES AND COSTS OF EQUIPMENT

It is becoming increasingly difficult if not impossible to pigeon-hole computers into little slots. The distinction between micro, mini and large computers is not clear. So imagine all types of computers on a continuous scale, with micro-computers at one end and large computers at the other. Modern computers do not differ much in terms of their speed of operation because they all use the same technology, namely large (or very large) scale integrated circuits. With this technology, speed is becoming limited by the actual speed of the flow of electrons. Circuits are so small that speed is determined by how long an electrical current takes to get from one point in the circuit to another. One main difference between systems is how many characters are moved within those circuits within a given period of time. At this time most micro-computers move one character at a time. Most mini-computers move two characters at a time and larger systems can move upwards of ten characters at a time. These definitions are not absolute. There are some micros that will move two characters and some large systems that move less than ten characters. It is generally true, however, that as you go up the scale more characters can be moved with a single operation. Thus these computers are faster and substantially more expensive. Also, as one moves along the scale from micro to larger systems, there is a noticeable difference in capacity. As mentioned, a micro might only support two floppy disks with a capacity of 1 million characters per disk, while a large computer might support billions of characters. While the cost of these disks go up as they get larger, the cost per character goes down dramatically. To illustrate this point I would like to present some relative costs associated with equipment we have at the National Inventory. (See Table 1). Although floppy disks are the least expensive unit to purchase, the cost per character is the highest.

Table 1: Operating costs[a] of storage disks used with different sized computers.

	Capacity of Computer (Characters)	Cost/month[b]	Cost/million characters/month
Floppy disks (micro-computer)	1,000K	$120.00	$120.00
Hard disks (micro-computer)	22,000K	$240.00	$10.91
Hard disks (small mainframe, Univac 90/30)	200,000K	$1,600.00	$8.00
Hard disks (large mainframe, Cyber 720)	1,600,000K	$1,000.00	$0.62

a. Costs estimated by the National Inventory Programme, National Museums of Canada, Ottawa.

b. Cost/month is calculated at $42./$1,000. of computer's purchase price.

Although volumes would be required to determine all the considerations necessary to select a system, I hope this contribution has served to emphasize that not all data processing applications are the same. When selecting computer equipment, it is important to have a good understanding of the problems and characteristics of the specific applications.

PHOTOGRAPHS FOR COLLECTION DOCUMENTATION

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LAMBERT, P., A.E. PEDEN and B. COOKE 1983. Photographs for collection documentation. Abstract of poster-paper presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 141-142.

ABSTRACT- Living colour, form and texture of soft-bodied invertebrates and fish are difficult to preserve and maintain. A number of chemical relaxers are available but success with their use has been variable. Moreover, chemicals designed to preserve the coloured pigments of specimens are even less successful and often the proper hardening of tissues suffers. Until some new ways to preserve animals with their original colour and form are found, colour photographs of living specimens are probably the best way to record these properties. Photographs complement preserved specimens immensely. Anyone concerned with the collection and storage of natural history specimens should give serious consideration to cataloguing photographs along with specimens and should also develop cataloguing techniques for the long-term storage of film. Collectors are urged to make every attempt to obtain documentary photographs of live specimens at the time of collection and devise new methods and standards for such ancillary documentation.

The British Columbia Provincial Museum has a collection of 8,500 slides, 3,000 colour prints and 2,000 black and white photographs of marine animals taken in their natural habitat, in special photographic tanks or freshly caught. These photographs not only document forms, colours, habitats, and behaviours but provide excellent illustrations for various types of publications, museum displays, and educational programs.

RESUME- La couleur, la forme et la texture originale des invertébrés à corps mou et des poissons sont difficiles à préserver et à maintenir. On peut utiliser certains décontracturants chimiques, mais les résultats sont inégaux. En outre, les produits chimiques conçus pour préserver la pigmentation des spécimens sont encore moins efficaces et entravent souvent le durcissement adéquat des tissus. D'ici à ce que l'on découvre de nouvelles façons de préserver la couleur et la forme originales des animaux, les photographies en couleurs représentant les spécimens vivants sont probablement la meilleure façon d'enregistrer ces propriétés. Les photographies complètent parfaitement les spécimens préservés. Quiconque s'occupe de collections et d'entreposage de spécimens d'histoire naturelle devrait sérieusement envisager la constitution d'un catalogue de photographies accompagnant les spécimens et mettre au point des techniques de catalogage pour l'entreposage à long terme de la pellicule. Les spécialistes qui recueillent les spécimens doivent faire tout en leur pouvoir pour se procurer des documents photographiques des spécimens vivants au moment de l'acquisition et élaborer de nouvelles méthodes et normes pour la constitution de cette

documentation secondaire.

Le British Columbia Provincial Museum possède une collection formée de 8 500 diapositives, de 3 000 photos en couleurs et de 2 000 photos en noir et blanc, représentant des animaux marins dans leur milieu naturel ou prises dans des réservoirs spécialement aménagés pour la photographie ou immédiatement après la capture des spécimens. En plus de constituer une documentation sur la couleur, l'habitat et le comportement des spécimens, ces photographies conviennent à merveille à l'illustration de diverses publications, aux expositions et aux programmes éducatifs.

COLOUR MEASUREMENT OF ENTOMOLOGICAL SPECIMENS

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McKILLOP, W.B. and W.B. PRESTON 1983. Colour measurement of entomological specimens. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 143.

ABSTRACT- (McKillop, W.B. and W.B. Preston) 1981. Colour measurement of entomological specimens. CAN. ENT. 113:255-258, 2 figures, 1 table, abstract, résumé). Frequently descriptive entomology suffers from a lack of precise data on specimen colour. Since colour is rarely defined and since an effective technique is available, the authors suggest that greater consideration be given colour analysis. A simple procedure is outlined in relation to colour analysis of specimens undergoing degreasing.

RESUME- (McKillop, W.B. et W.B. Preston, 1981. Colour measurement of entomological specimens. CAN. ENT. 113: 255-258, 2 figures, 1 tableau, abstract, résumé). L'absence de données précises sur la couleur des spécimens est souvent un problème en entomologie descriptive. Parce que la couleur est rarement précisée, bien qu'une technique efficace soit disponible à cet effet, les auteurs proposent d'accorder plus d'importance à l'analyse de la couleur. Une méthode simple est décrite pour analyser la couleur de spécimens devant être dégraissés.

COMPUTERIZATION OF THE HERBARIUM OF THE UNIVERSITY OF BRITISH COLUMBIA

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PINDER-MOSS, J. 1983. Computerization of the herbarium of the University of British Columbia. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 145-149.

ABSTRACT- This paper discusses the data entry, storage, retrieval, and the associated costs and problems of the computerization of label data of the collections of the U.B.C. herbarium.

RESUME- L'herbier de l'Université de la Colombie-Britannique a informatisé l'enregistrement et le rappel des données relatives aux collections. Le présent article traite de l'entrée des données préliminaires, de la mise en mémoire, de la recherche, ainsi que des coûts et problèmes liés à l'informatisation des données portées par les étiquettes des collections de l'herbier.

INTRODUCTION

The University of British Columbia has excellent computer facilities with an Amdahl V8 as its central piece of hardware and MTS as its operating system. Data are entered on a visual display terminal using an interactive mode.

In 1978 a representative of the Botany Department wrote the Director of the National Inventory Programme, National Museums of Canada, Ottawa, to inquire about financial assistance for computerizing the U.B.C. Herbarium. He replied that funding for such university projects was not available, so the Herbarium with funds made available by Dr. Robert Scagel, Head of the Botany Department, and under the direction of Dr. Jack Maze, hired a graduate student to develop programs for herbarium information input and retrieval. The resulting data-bank will only become useful when most of the collections have been entered. Data can be improved by expanding abbreviations which frequently are ambiguous or unintelligible.

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The computer has improved the efficiency of producing better labels. The computerization of the herbarium will allow an expanded use of our holdings by the public while traditional users can still refer to actual specimens.

DATA ENTRY

Our data-entry program is designed so that the information goes into twenty-three fields based on the National Museum's codes which have been developed for computerizing anthropological and historical museum collections. We selected the ones pertinent to an herbarium, ensuring that some fields are semi-permanent while others must change with each specimen. Examples of semi-permanent fields are: herbarium designation, in our case, U.B.C.; country; and province or state.

When any of these fields must be changed, the program questions the user as to whether or not he actually wishes to make a change. It queries whether the field number has been entered in error. Some fields are related to others. If the operator changes the province or state (field 23) he or she will be asked "do you wish to change province or state" from British Columbia to Alberta, for example; but if the country has been recently changed, the change of province or state is accepted without question. The accession number and the collector's number must change with each specimen. If these numbers are going to increase by increments of one throughout that particular session of data entry, the program will automatically enter the new numbers for each specimen, once the first number has been established. The other fields do not have to be changed unless it is necessary. The computer only remembers which fields have been changed. The program has been set up logically so when the user changes the locality without changing latitude, longitude, depth, altitude or habitat, it will query the operator.

All labels are now made by the computer. Previously, the labels were typed; and if specimens had information in common, a master label was typed, photocopied, and then photocopied labels were typed with the specific information. This tedious process has been eliminated. When the label file grows to a reasonable size, a batch job is run overnight (at low cost) on thesis-quality paper and six labels per page are printed by a laser printer in the computer center. The pages are then cut up into labels and matched with the specimens.

The file which used to make labels has been transformed into the file 'herb.with.ac' which at present holds most of our entered data. It is possible to designate the file that the information will go into before entering the data, so that it can be kept separate. This is important for loans being sent out. Label data are kept separate in anticipation that annotations will require extensive editing of the entered data.

Data is thus entered into a temporary file which can be seen on the screen to check for mistakes. Accuracy is very important, especially for later information retrieval. The data, once it has been checked, is transferred to a permanent file. It is still possible to correct errors or omissions in this disc file using the M.T.S. editor, but it costs more than using the program. When the users have filled the disc, the files are transferred to magnetic tape which is stored in the Computer Center.

DATA STORAGE

Once the data has reached the magnetic tape, it becomes extremely difficult to correct errors. The contents of the tape must be transferred onto disc to be searched, and until very recently this was difficult and expensive.

The final storage on magnetic tape is done at a separate computer facility "The Biological Data Center, U.B.C." which has a PDP-11 computer using UNIX. Data is transformed from the entry format to a single line for each specimen using delimiters between fields and sorted by herbarium section. Each specimen is given a unique accession number commencing with a letter, V for vasculars, A for algae, B for bryophytes, L for lichens, or F for fungi. Before final storage the specimens are separated by the accession letter into separate magnetic tapes. Data could be organized alphabetically by genus and species, but this is considered unnecessary since the UNIX system has an excellent data retrieval system, using a program called AWK.

DATA RETRIEVAL

The data retrieval system set up previously proved unworkable. For nearly a year we were entering files onto tape without easy access to it. AWK is able to retrieve information from any field, combination of fields, or any word within a particular field. Thus, one could ask the data bank for all the specimens collected at Kamloops by John Macoun during 1899. Or one could ask for all the collections of a particular collector and all the data associated with those collections. AWK has been used to generate a printed copy of all the lichens collected in B.C. which have been entered, organized alphabetically by genus and species.

AWK has also been used to scan all the words in the locality field within the vasculars and printed out each word and the number of times it has been used. Thus errors and variations in spelling can be spotted. This has also been done in a separate job for the genera and species of the vascular herbarium. Different floras used different spellings for the same word: eg. *pyroliflorus* and *pryolaeflorus* or *caespitosa* and *cespitosa*. These variations which are carried into data entry should be known when searching for data so that no specimens are overlooked.

COMPUTERIZATION TIME AND COSTS

Data entry for labels for the three sections - bryophytes, lichens, and vasculars - cost an average eleven cents per label. Generally, this breaks down to seven cents for computer and printing costs and four cents for the operator's time. On an average 137 labels can be made per hour of entry time. The cost of entering data from already filed specimens is higher. On an average it costs twenty-seven cents per specimen in computer time with 27 specimens entered per hour. The operator's time would be twenty cents per specimen so that the total expense per specimen is $.47. The algae herbarium, where many specimens of the same species come from the same locality, have pushed down the cost of data entry to about seven cents per specimen for computer time.

The actual costs of data retrieval are still premature. The computer will aid in searching for specific groupings of fields that are now impossible to accomplish manually. All retrievals will be done on a low priority basis i.e., overnight, so costs will be minimized.

DISCUSSION

The problems associated with computerization of the herbarium are small. All files are backed up on tape so that an accidental erasure will not lose valuable data. The label data file is retained in its original form after labels have been printed, just in case printing goes awry. Since we have limited disc space on the computer, users have to ensure that there is adequate space for this file and the version which is saved for permanent record.

The biggest problems are only now emerging, for example we must edit a large and unwieldy data base. This editing is expedited with the UNIX system, but it still takes 24 hours to find, correct and reassign the specimen data to the tape. This is a shorter time than the Museum of Anthropology, U.B.C., which requires about two weeks to retrieve data from their computerized holdings stored at the National Inventory Programme, N.M.C., in Ottawa. There is limited space on a label, and if the information is too great for that space, the computer automatically shrinks the information, usually by omitting field 48, notes; and by limiting the size of such fields as 27, locality; and 43, habitat. These fields are retained in full within the computer, but they do not show completely on the label. Also, all spaces are removed between fields, so that more information can be printed. And finally there are problems concerning the video display terminal. Nobody likes to work on it more than two or three hours at one time, since it requires full concentration and causes eye strain. At least one user has been bothered by a high-pitched hum which was remedied by wearing earphones.

REGIONAL COLLECTIONS AND THE CONCEPT OF REGIONAL CENTRES

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DANKS, H.V. 1983. Regional collections and the concept of regional centres. In: Proc. of 1981 Workshop on the Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 151-160.

ABSTRACT- The Biological Survey of Canada (Terrestrial Arthropods) was developed as a focus for national discussion and guidance of systematic and faunistic entomology. Therefore, one general concern of the Survey is the status of resources of preserved material in collections. The existing collections of Canadian terrestrial arthropods are discussed. More than half of the estimated 16 million specimens in collections are in the Canadian National Collection, but there are about 50 other collections in Canada that contain more than 10,000 specimens each. Some of these are deteriorating through lack of maintenance. The Biological Survey believes that the support and development of regional centres based on regional collections (in addition to a strong National Collection) are essential to proper study of the fauna. Such regional centres would serve not only as focal points for curation and identification of specimens, but also would underpin research, education and reference in a broader context. Some preliminary ideas about the development of regional centres are summarized.

RESUME- La Commission biologique du Canada (Arthropodes terrestres) a été mise sur pied pour guider les travaux en entomologie systématique et faunique et pour favoriser les échanges d'information à l'échelle nationale. La Commission s'intéresse donc en général à l'état des collections de spécimens préservés. L'article traite des collections actuelles d'arthropodes terrestres du Canada. Plus de la moitié des quelque 16 millions de spécimens des collections appartiennent à la Collection nationale du Canada, mais il y a au pays environ 50 autres collections qui possèdent chacune plus de 10 000 spécimens. À défaut d'entretien, certaines se détériorent. La Commission biologique croit qu'il est indispensable de créer et de soutenir des centres régionaux s'occupant de collections régionales (en plus d'une collection nationale bien étoffée), afin d'étudier adéquatement la faune. Les centres régionaux ne se contenteraient pas de servir d'avant-postes pour la conservation et l'identification des spécimens; ils pourraient aussi étayer la recherche, l'éducation et la diffusion dans un contexte plus large. L'article présente brièvement quelques idées générales au sujet de la mise sur pied de centres régionaux.

INTRODUCTION

Insects and their relatives are the most diverse group of animals, and over 66,000 species, half of them as yet undescribed or unreported, are estimated to occur in Canada (Table 1). The need for concerted study of this variety of species, and the size and diversity of the country, led to the establishment of the Biological Survey of Canada (Terrrestrial Arthropods), which began in 1977 as a Biological Survey of the Insects of Canada (Downes 1977; Danks 1978).

The Survey's major role is to catalyse relevant work on the terrestrial arthropod fauna, through scientific discussion and actions based on knowledge of available resources of personnel, programs, and facilities. One important resource is the material preserved in collections and this has been inventoried (Biological Survey Project 1978). Some proposals for the establishment of regional centres, based on these resources, are also being developed, and preliminary ideas about this concept are outlined here.

TABLE 1: *NUMBER OF SPECIES OF TERRESTRIAL ARTHROPODS RECORDED FROM CANADA AND OTHERS ESTIMATED TO OCCUR THERE BUT NOT YET RECORDED (FROM DATA IN DANKS 1979)*

	Species known from Canada	Estimated additional species
Insecta	29,976	24,673
Arachnida	3,225	7,711
Other terrestrial arthropods	472	462
Totals	33,672	32,826
Estimated total number of terrestrial arthropods in Canada	66,498	

COLLECTIONS OF CANADIAN TERRESTRIAL ARTHROPODS

About 16 million specimens of terrestrial arthropods are preserved in nearly 100 collections in Canada; only about one quarter million specimens are held outside the country (Table 2). Much of the material (over 60%) is in the Canadian National Collection in Ottawa but other collections, in locations throughout Canada, contain over 6 million insects and related forms.[1] Data shown by province in Table 3 indicate, however, that except in Ontario and Quebec few sites have accumulated very large collections.

The distribution of the collections broadly follows that of the human population (Fig. 1), since regional collections were chiefly built up in institutions not exclusively concerned with entomology where a particular interest in insects was fostered in the past by one or several entomologists who worked there. Unfortunately, such a history commonly means that if the founder of a collection moves or retires, no general mandate to curate the material exists. Consequently, several of the collections have deteriorated significantly or have been partly destroyed through lack of care or inadequate housing, or through improper or improperly supervised use.

TABLE 2: *SYNOPSIS OF COLLECTIONS CONTAINING TERRESTRIAL ARTHROPODS FROM CANADA (FROM DATA IN BIOLOGICAL SURVEY PROJECT 1978)*

	No. of collections	Approx. no. of specimens
Canadian National Collection in Ottawa	1	10,000,000
Other collections in Canada	97	6,000,000
Collections outside Canada	37	250,000

THE NEED FOR REGIONAL COLLECTIONS

This information reinforced ideas developed by the Biological Survey about the need for regional collections, in addition to a strong National Collection.

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[1] For comparison, the National Insect Collection of Australia, where there are several well-established state museums with extensive collections, contains only about 30% of the total of over 16 million specimens, mostly from Australasia (Australian Biological Resources Study 1978); on the other hand, about 80% of the insect specimens in British collections are at the British Museum (Natural History), which holds about 22 million specimens, many of them from overseas (Smith 1979). The United States National Museum contains over 18 million arthropod specimens, but this compares with over 60 million in 19 other major U.S. collections (Conference of Directors of Systematic Collections 1971), and there are numerous other substantial collections throughout the country.

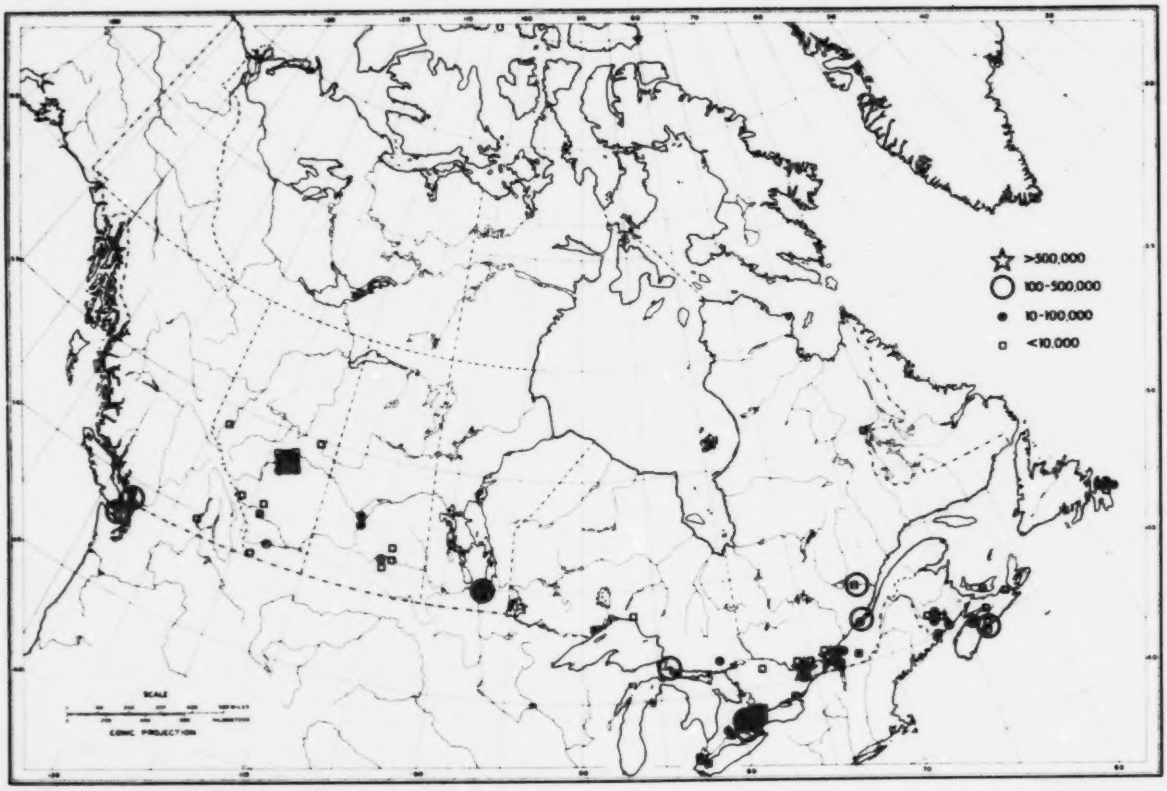
☆ >500,000
○ 100-500,000
● 10-100,000
□ <10,000
SCALE
CONIC PROJECTION

FIGURE 1: *Location and approximate holdings of canadian collections of terrestrial antropods.*

Regional resources are required for various reasons in a country as large and diverse as Canada. On the one hand, regional situations and associated problems can usually best be studied or managed locally. On the other, central facilities are difficult of access from distant points. These features are well recognized in the provision of universities, libraries, research stations and ecological preserves, for example.

In particular, existing local collections provide valuable and representative specimens of regional faunas; as such they are part of Canada's national heritage (Biological Council of Canada 1977). Similar conclusions have been drawn for other countries (e.g. Irwin et al. 1973 for the United States of America; Smith 1979 for Britain). In some cases, specialized Canadian collections are as good or better, in particular aspects, than the National Collection. For instance, the Lyman Entomological Museum (Macdonald College of McGill University) has by far the best Canadian collection of Orthoptera.[2]

TABLE 3: *SYNOPSIS OF COLLECTIONS OF TERRESTRIAL ARTHROPODS IN CANADA WITHIN PROVINCES (FROM DATA IN BIOLOGICAL SURVEY PROJECT 1978)*

Province	No. of specimens	No. of collections	No. of cities with collections	No. of cities with more than 100,000 specimens
Alberta	480,000	16	7	1
British Columbia	549,000	8	3	2
Manitoba	261,000	5	1	1
New Brunswick	131,000	6	3	1
Newfoundland	57,000	4	1	0
Nova Scotia	402,000	8	4	1
Ontario	12,529,000	31	19	5
Prince Edward Island	2,000	1	1	0
Quebec	1,555,000	13	10	3
Saskatchewan	158,000	6	4	0
Totals	16,124,000	98	53	14

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[2] In such cases, national taxonomic expertise in the group is in practice maintained locally.

Regional collections serve various local needs, such as those of the universities and provincial governments. Indeed, many of the larger collections have underpinned past work of great value, and the material in them is referred to extensively in the scientific literature. Current levels of support rarely reflect these facts (cf Knutson 1978).

Existing collections represent a very significant investment. Some material in them is irreplaceable, because it documents previous work (e.g. type specimens, and voucher specimens for ecological work) or comes from sites now changed by development. The Biological Council of Canada (1977) pointed out that such permanent reference materials are essential for the orderly growth of knowledge, for the scientific method requires that findings reported earlier should be open to reevaluation.

In addition to these unique reference materials, collections contain other items with a high replacement value. Each specimen represents at least 10 minutes work of collection, preparation, labelling, identification and curation (the time spent depends on the group and the level to which material has been identified, and 10 minutes is probably a serious underestimate). Thus the 260,000 specimens in Winnipeg (Table 3), for example, cost at least 50,000 scientist hours. The slightly larger collection of insects at the Spencer Entomological Museum in Vancouver has been valued at over one-quarter million dollars (Zoological Museum, U.B.C. 1977).

Finally, in addition to these sorts of materials, many museums contain general collections used for teaching or exhibition (Mound 1978). These uses tend to damage specimens, so that they usually require material that is separate from the reference collections and can be readily replaced.

THE CONCEPT OF REGIONAL CENTRES

Regional centres are proposed as necessary focal points for work on the fauna of each region. They would allow not only the maintenance of systematics collections, but through links with other facilities would amplify their use and permit broader resources and expertise to be marshalled toward understanding the fauna. Regional centres would thus promote (Fig. 2) research, education and reference, as well as underpinning regional needs for identification or the storage of voucher specimens for ecological work (cf Yoshimoto 1978).

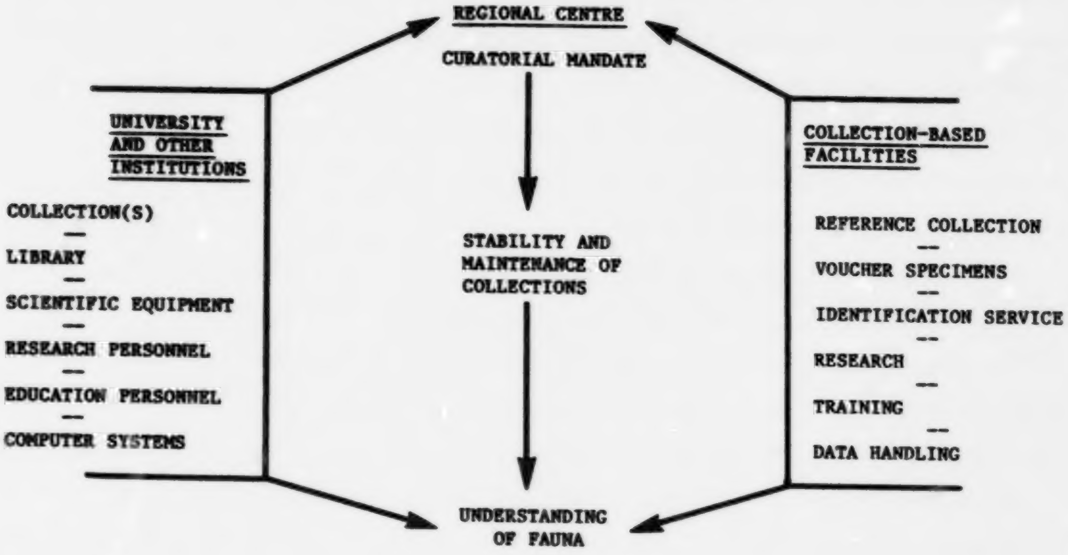
REGIONAL CENTRE
CURATORIAL MANDATE
UNIVERSITY AND OTHER INSTITUTIONS
COLLECTION(S)
LIBRARY
SCIENTIFIC EQUIPMENT
RESEARCH PERSONNEL
EDUCATION PERSONNEL
COMPUTER SYSTEMS
STABILITY AND MAINTENANCE OF COLLECTIONS
COLLECTION-BASED FACILITIES
REFERENCE COLLECTION
VOUCHER SPECIMENS
IDENTIFICATION SERVICE
RESEARCH
TRAINING
DATA HANDLING
UNDERSTANDING OF FAUNA

FIGURE 2: *GENERAL CONCEPT OF REGIONAL CENTRES.FOR EXPLANATION, SEE TEXT.*

The establishment of such centres depends on liaison - according to regional circumstances - among provincial museums, universities, and other establishments including research units (such as those studying biting-flies) and federal or provincial government research institutes or stations in biologically orientated agencies such as Departments of Agriculture.

A valuable function of regional centres would be as resources for advanced training related to biosystematic research. The need for improved and more extensive training in systematics, if biological problems are to be solved, has been recognized from an international perspective (e.g. International Union of Biological Sciences 1979; Watt 1976), and systematics service and research centres to support development overseas have a primary importance (e.g. Lattin 1980).

This concept has its roots in the scientific importance that collections have in research related to regional ecology, environment, conservation, and management, and in associated functions such as academic education. Regional centres also have substantial value for other more general purposes, in exhibition and public education, and in responding to enquiries from the public, for example. McKillop (1981), however, believes that such general uses may in the near future become more conspicuous in regional museums at the expense of research-orientated activities. However, a diminution of regional research not only would be harmful to any nationwide understanding of the fauna, but also removes the very activity that can assure the quality of general services.

A key requirement for the development of regional centres is a curatorial mandate that allows for the stability and maintenance of collections for various purposes (Fig. 2), and so provides also the focus for liaison. To ensure continuity and overcome the problems described above that result from the history of development of certain collections, this must be central (i.e. federal) mandate, but it does not follow that only one institution need be designated as the single recipient within a region. Rather, the curatorial resources would be made available to allow for the proper care of all collections in one or more sites in a given area. Such a mechanism allows for the curation of collection resources without the need to combine existing collections. Combination of collections may sometimes be desirable, but would not be essential. The staff charged through federal mandates with the maintenance of these collections would of course be based in larger centres within each region, but this would not preclude visits elsewhere in the region.

This proposal implies that, after suitable local discussions, regional centres could be catalyzed merely by the provision of curators and technical assistants. These would work in existing institutions, but would have responsibility for the upgrading and use of resources of preserved arthropod material in the region as a whole.

Much more elaborate and expensive plans have been suggested for the support of the many collections in the U.S.A. (e.g. Irwin *et al.* (1973). A national plan developed for systematic entomology in the United States includes the designation of "resource centres" of various types (see Fisher *et al.* 1974), but these plans have not so far been funded.

Regional centres for systematic and other work would also facilitate a rational system for handling faunal data. This could be developed as long-term goal, not only extending the limited inventories of existing collections of various sorts that are available through the National Inventory Programme of the National Museums of Canada (National Inventory Programme 1977), but also providing better access to important taxonomic and ecological information. This complex question (e.g. Gautier 1978; Huber *et al.* 1978; Crovello *et al.* 1980) is also being addressed by the Biological Survey of Canada.

FUTURE DEVELOPMENTS

Several problems will arise as more specific proposals are generated by these general ideas.

One problem concerns the selection of locations, and will require detailed discussions among interested parties in each area. However, a regional rather than strictly institutional mandate, as just outlined, avoids one set of problems by ensuring that advantages are shared, not limited to only one "chosen" establishment. In addition, the number of possible alternative locations is smaller than might be anticipated, because most larger collections are in moderately scattered major centres (Fig. 1; compare the final column of Table 3).

A second problem concerns the taxonomic coverage of the collections, for the ideas about regional centres in this paper have been developed from information on the terrestrial arthropods. Ideally, an appropriate scheme of regional centres would allow all groups of animals and plants to be treated. Fortunately, the placements of major Canadian systematics collections of organisms other than insects resemble those shown here. The Biological Survey of Canada hopes that eventually the National Museum of Natural Sciences, especially through its interactions with associated museums, will be able to play a leading role in bringing some of these ideas to fruition.

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PLANTS: FROM THE FIELD TO THE HERBARIUM

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GILLETT, J.M. 1983. Plants: from the field to the herbarium. In: Proceedings of the 1981 Workshop on the Care and Maintenance of Natural History Collection, edited by D.J. Faber, *Syllogeus* No. 44: 161-167.

ABSTRACT- The standard procedures for the preparation of herbarium specimens is traced from the plant in the field through the drying, mounting and labelling process. This article was prepared to assist those who wish to prepare such specimens but are unaware of the processing as carried out in a major herbarium.

RESUME- Les méthodes normalisées de préparation des spécimens d'herbier sont décrites, de la découverte de la plante sur le terrain jusqu'au procédé d'étiquetage, en passant par le séchage et le montage. Le présent article traite des méthodes mises au point au fil des ans à l'Herbier national du Canada, tenu par le Musée national des sciences naturelles, à Ottawa. Des renseignements détaillés sont fournis à ceux qui désirent préparer des spécimens d'herbier pour un entreposage de longue durée.

INTRODUCTION

This paper discusses procedures for the preparation of herbarium specimens as followed at the National Herbarium of Canada, National Museum of Natural Sciences in Ottawa. Herbarium specimens are necessary because in that way plants can be captured at a particular point in time and preserved for later study. These procedures are useful for the preparation of specimens under average temperate zone conditions, but are often unsatisfactory for tropical conditions or for extreme plant forms. For example, the preparation of a palm frond or the preservation of a cocoanut requires a special technique as it is not possible to fit them on a standard 11½" x 16½" herbarium sheet.

TECHNIQUES OF COLLECTING PLANTS

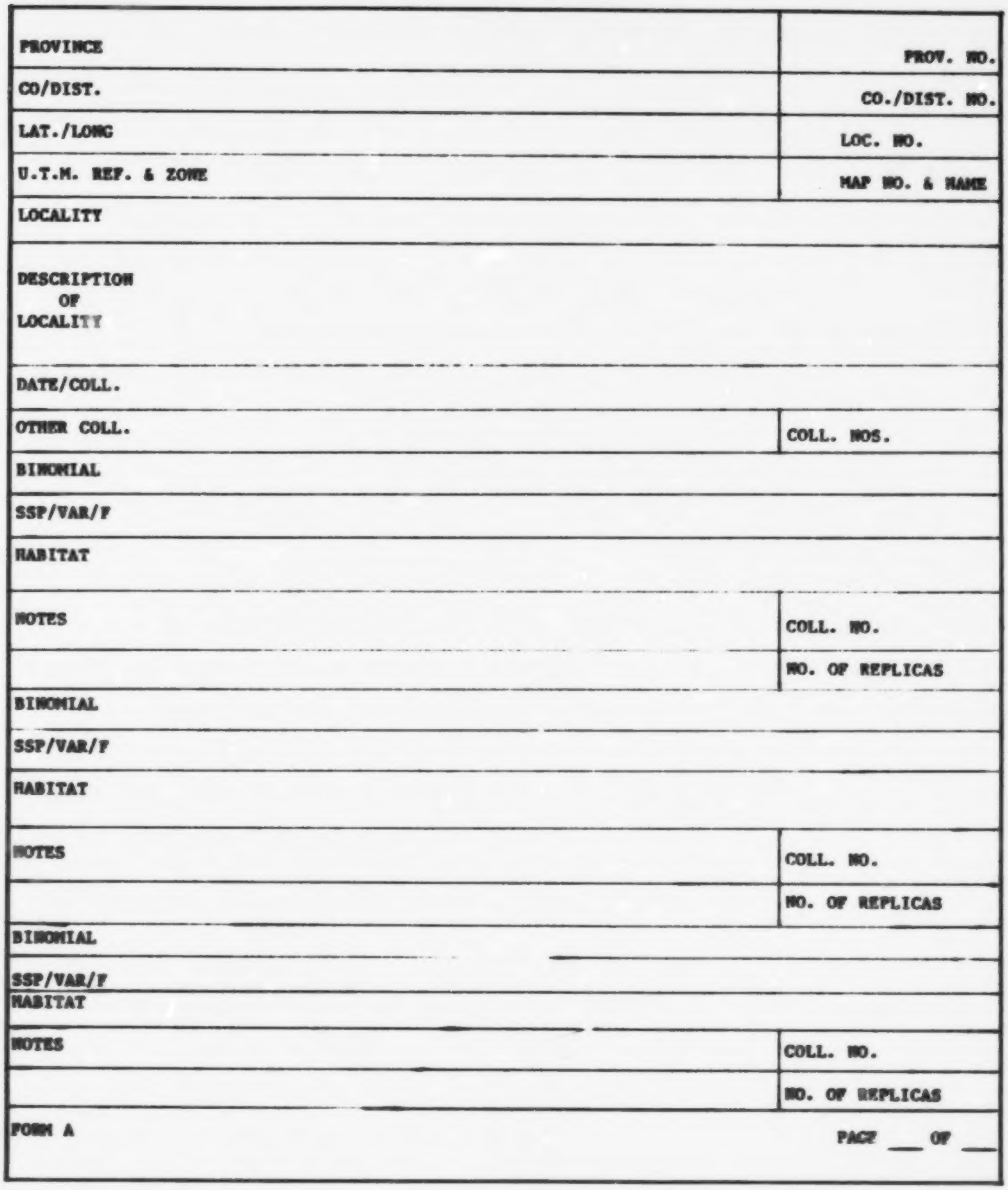
Herbaceous plants are dug up, the soil removed by shaking or washing, and the plant laid out on newspaper so that all parts are displayed without overlapping. Sometimes this may necessitate thinning of parts or removal of branches. Some leaves may be turned over so that the underside is displayed, thick stems are sliced longitudinally and inflorescences may also require thinning. Often stubs of flower stalks, or portions of compound leaves are left to indicate the original size or shape. In the case of shrubs or trees, portions of branches bearing flowers or fruits are cut with a knife or secateur. Large fruits or cones may be collected separately in paper bags. At the time of collection, notes are taken on precise locality including: latitude and longitude, altitude (if known), description of habitat, abundance, colour of flowers, odour, stickiness, or any other feature which may be lost upon drying. The collection is assigned a collector's number, which is written on the sheet. The date is recorded. It is preferable to write the number on the lower right-land corner, so that the generic name can be written on the left-hand corner for later sorting. Any replicate sheets made at this time must bear the same number as the first.

Various collection numbering systems can be used. The most common is to use a continuous series which runs from one year to the next. This method is good, but numbers can become large and unmanageable after many years. Another method is to preface the number with that of the year and begin with 1 again for each season. The exact method used is up to the individual collector, but it is important to assign one because it serves to identify the collection throughout processing and later can be used, along with the collector's name, to cite the specimen in a manuscript.

For digging plants, the choice of a digging tool is important. It must be strong enough to use in almost any kind of soil. Garden trowels are never a good choice because they are designed for friable cultivated soil and will usually break when used to cut through sod. I use a ground-down bayonet. By grinding it to a dull point there is no danger of spearing someone with it, and it is almost impossible to break by prying. A set of secateurs (pruning clippers) are especially useful for making specimens of twigs or branches.

After the specimen has been gathered, it is laid out on newspaper. At the National Herbarium plain newspaper is used, because newsprint is distracting (especially the comics), and specimens are not as visible against a printed background. Furthermore, printed material is not acceptable for exchange with certain institutions for political reasons.

The folded papers containing the specimens are placed in a plant press which consists of two frames made of strips of ash, or plywood cut a little larger than an herbarium sheet. Within the frame, corrugated cardboards are placed with the corrugations running transversely.



PROVINCE	PROV. NO.
CO/DIST.	CO./DIST. NO.
LAT./LONG	LOC. NO.
U.T.M. REF. & ZONE	MAP NO. & NAME
LOCALITY	
DESCRIPTION OF LOCALITY	
DATE/COLL.	
OTHER COLL.	COLL. NOS.
BINOMIAL	
SSP/VAR/F	
HABITAT	
NOTES	COLL. NO.
	NO. OF REPLICAS
BINOMIAL	
SSP/VAR/F	
HABITAT	
NOTES	COLL. NO.
	NO. OF REPLICAS
BINOMIAL	
SSP/VAR/F	
HABITAT	
NOTES	COLL. NO.
	NO. OF REPLICAS
FORM A	PAGE ___ OF ___

FIGURE 1: *Form A is filled in by hand after a collecting trip. This form contains all the data about the collection. There is a Form B which simply contains the lower portion of Form A.*

The transverse corrugations are important because when the press is put together for drying, air must pass through these corrugations when the press is placed on its side. Each sheet of cardboard is covered with a sheet of ¼ in foam (blotting paper was once used but is not as satisfactory), then newspaper containing the plant. The process is repeated until a stack of about 30 specimens have been built up into a pile. Then the second frame is added, and the whole pile held together with two straps. The strap buckles are tightened using the weight of the body to compress the stack, but not compressed so tightly as to damage the frames. On return to camp or laboratory, the presses are placed on a frame and heated by convection over 100-150 Watt light bulbs, or a tent warmer, if no electricity is available. If drying is performed in the laboratory, presses are placed on the screened shelves of a cabinet-type drier for a period of 1-2 days at 38°C (100°F). Following the drying process, the folded newspaper containing the specimens are removed and tied into bundles. Later they are sorted by genera for ease of identification.

It is often desirable to collect plants either in portfolios or in sacks, when travelling through a forest or operating a long way from a vehicle. With the portfolio method one carries a bag of the same length and width as a press but which has pockets for placing sheets of newspaper. The empty newspaper is kept separate from those containing plants by a couple of sheets of corrugated cardboard. The plants, as collected, are then able to wilt, more or less in place, in the field and the newspapers can then be transferred to the press later, while preparing them a little more carefully. If there is no time to do this, after a day's collecting, then one can place the portfolio in a cold room or refrigerator for the night and continue in the morning; or, one can wet down the entire portfolio with water and leave it in a cool place overnight. In the morning the paper will have to be replaced.

With the sack method, a number of small plastic bags can be used to gather specimens to keep each collection separate from others. Then all the sacks can be placed in a larger sack, such as a garbage bag. On return to the laboratory or vehicle, specimens are laid out on newspaper, as described before. The disadvantage of this method, which is really a modification of the old vasculum technique where a cylindrical tin box was used, is that petals tend to be shed and fruits become entangled. Another good method, which is used a great deal by European collectors, is to affix a paper with string to the stem of the plant. The collection number is assigned in the field and written on the tag.

RULE TABLE DEFINITION

JOB: ______________________

Institution: ______________________

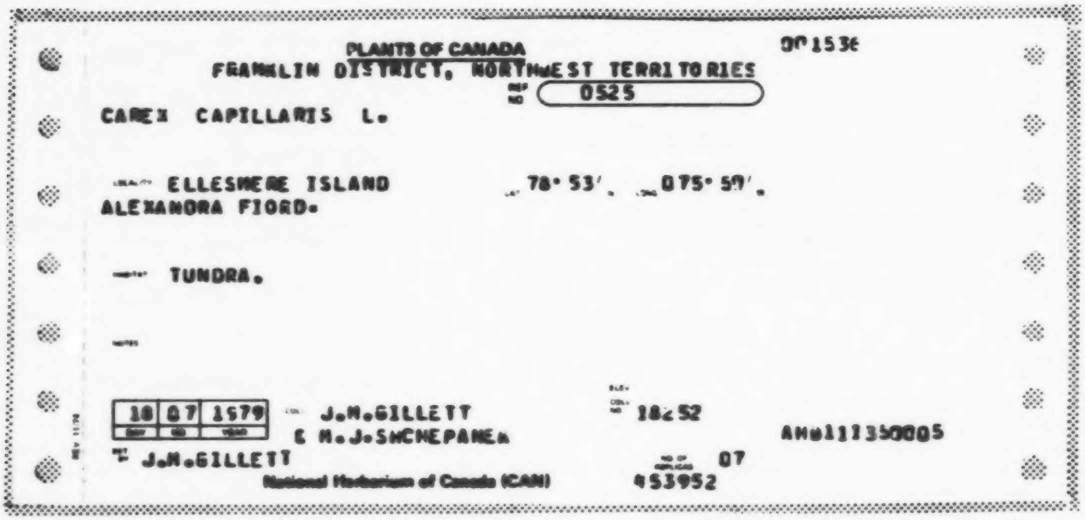
Date ______________________

#	TAG	NAME	#	TAG	NAME
01		RECORD NUMBER	22		UTM NORTHING
02		INSTITUTION	23		UTM ZONE NUMBER
03		ADDRESS	24		TOWNSHIP/RANGE/SECTION
04		COUNTY OR DISTRICT	25		HABITAT
05		PROVINCE	26		NOTES
06		GENUS NUMBER	27		ALTITUDE
07		GENUS	28		COLLECTION DATE
08		SPECIES	29		PRINCIPAL COLLECTOR
09		BINOMIAL AUTHORITY	30		SORT COLLECTOR
10		SUBSPECIES	31		PRINCIPAL COLLECTOR'S NUM
11		SUBSPECIES AUTHORITY	32		OTHER COLLECTORS
12		VARIETY	33		DETERMINER
13		VARIETY AUTHORITY	34		NUMBER OF REPLICAS
14		OTHER CATEGORY	35		ACCESSION NUMBER
15		OTHER CATEGORY AUTHORITY	36		MAP REF. # + NAME
16		LOCALITY NAME	37		FAMILY
17		LATITUDE	38		KIND OF SPECIMEN
18		LONGITUDE	39		LITERATURE REFERENCES
19		LOCALITY DESCRIPTION	40		
20		LOCALITY NUMBER	41		
21		UTM EASTING	42		

FIGURE 2: *The Label Records Field List is the form that is used to generate labels.*

TECHNIQUE OF DOCUMENTING PLANTS

After plants are identified, the number of replicate sheets for each collection is estimated, although this may be done at the time of collection. Data for the collections are then entered on printed forms (Fig. 1) for use by the computer operator. All common data such as collector, locality (including latitude and longitude), date, map number and name, go at the top. Variable data such as plant binomial, habitat, notes, collector's number, and number of replicates are entered by hand below. These data are entered by the operator at the terminal, which is connected by telephone to a Univac 9030 computer located in the Ottawa offices of the National Inventory Programme. For this purpose the operator follows a Field List (Fig. 2). The terminal operator adds the *Dalla Torre and Harms*[1] number, which we use to file specimens in the herbarium, as well as the herbarium accession number.



PLANTS OF CANADA

001536

FRANKLIN DISTRICT, NORTHWEST TERRITORIES

0525

CAREX CAPILLARIS L.

ELLESMERE ISLAND 78° 53'. 075° 59'.

ALEXANDRA FIORD.

TUNDRA.

10 07 1979 J.M.GILLETT 18252

& M.J.SHCHEPANEK AM0111350005

J.M.GILLETT 07

National Herbarium of Canada (CAN) 453952

FIGURE 3: *A copy of a plant label that has been computer printed.*

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[1] De Dalla Torre et Harms. Genera Siphonogamarum. 1958. J. Cramer, Weinheim. This book lists and numbers vascular plant genera.

Each sheet receives one accession number, which is used to keep a count of the sheets going into the herbarium. They can also be used to identify a particular specimen in a published paper. The data is returned as a Field List printout which is then proofread and returned. The final labels appear as a series in a continuous roll (Fig. 3). Each label has perforations which enables the label to be torn off and inserted with the specimen.

After the labels are inserted, one sheet is selected for mounting and any replicates are set aside for exchange purposes. The specimen is removed from the newsprint and Elmer's Glueall adhesive applied with a dispenser to the lower side. The specimen is strategically placed on the herbarium sheet, the label affixed to the lower right-hand corner. After placing the specimen on the sheet, the adhesive is also applied from the top at selected points. The specimen is held down by steel washers, placed on cardboard sheets separated by wooden blocks to form stacks which are left to dry. When the stack is dry (usually overnight is sufficient), the weights are removed and specimens stamped with the herbarium stamp and accession number. The specimens, which have the Dalla Torre and Harms generic number (labelled by computer), are sorted into piles and added to the herbarium.

Special items, such as thistle heads subject to shattering, are covered in transparent plastic sheets. Other items, such as cones or large fruits, are placed in plastic bags which are stored in trays. The trays fit on standard herbarium shelves. The labels are cross-referenced to the herbarium specimen.

The National Herbarium has an ongoing restoration program. Many earlier specimens were mounted on flimsy paper and others have become loosened. The specimen is cut from the paper and remounted along with the original label.

The National Herbarium has an active exchange program with other institutions. Replicate specimens, with computer printed labels, are sorted into piles for exchange. For example, if a collector had collected five specimens of a plant (say, *Trillium*), then the computer would generate enough replicate labels for the five specimens. The original sheet goes into the National Herbarium; the four replicates are sent out on exchange to institutions in Canada, or other herbaria throughout the world. These institutions in turn send us sets of their replicates, which contribute to the enrichment of our collection.

WHY SHOULD A MUSEUM MAINTAIN A LARGE COLLECTION?[1]

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LAUBITZ, D.R., C.T. SHIH and I. SUTHERLAND 1983. Why should a museum maintain a large collection? In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 169-171.

ABSTRACT- The functions of a zoological collection in a natural history museum are listed in the following categories: general collections for scientific studies; material for display and teaching; reference collections for identification and verification; faunal assemblage collections; and voucher collections of named specimens from special projects. The rationale for maintaining a large collection with duplicate specimens is explored.

RESUME- Dans un musée d'histoire naturelle, la collection de zoologie se subdivise en catégories fonctionnelles: matériel utilisé à des fins d'exposition et d'enseignement; collections de consultation pour l'identification et la vérification; collections d'assemblages fauniques; collections de spécimens de référence, identifiés dans le cadre de projets spéciaux. L'article traite des raisons justifiant le maintien d'une importante collection contenant des spécimens en double.

INTRODUCTION

Fundamentally, a museum is its collections. However, all museums have limited resources, and sooner or later collection managers are faced with the necessity of deciding whether the collection really needs to be expanded further. Is there any need to maintain a large collection, or should perhaps only the best specimens be kept?

A zoological collection in a natural history museum contains not only animal specimens, but also photographs, films, tapes and art work. These may be regional, national, or international in character. An animal species is made up of individuals of different ages, sexes, seasons and provenance, and the collection must contain enough material to illustrate this diversity. It must show the animal in terms of the full coverage of its geographical distribution, the breadth of its ecological habitat, and the changes that it undergoes during its life history. For each of these areas of diversity a number of specimens must be available to illustrate the extremes of variation found within the species. This cannot be done with only a few specimens from a restricted geographical locality.

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[1] A version of this article appeared in the Newsletter of the Canadian Natural History Curators' Group. 1981. No. 2:4-8.

A large collection can have material removed from it without impairment. This will be necessary where specimens are needed for displays and educational purposes. It can also be useful for effecting exchanges whereby new material can be acquired without expenditure of valuable resources. Other collections maintained within or as adjuncts to the general collection are dealt with below: reference collections, faunal assemblages, and voucher specimens.

GENERAL COLLECTIONS

Basically, the purpose of a zoological collection in a natural history museum is to provide useful and sufficient material which can be used in the pursuit of knowledge of the natural history of animals, the relationships between animals and their environment, and the role of mankind in nature. To accomplish these objectives, a zoological collection should have the following characteristics:

1) Useful for taxonomical studies. Modern taxonomy requires comparison of many individuals within a population and among different populations to illustrate the full extent of intraspecific variation.
2) Useful for zoogeographical studies. Materials from different areas should be represented to demonstrate the pattern of geographical distribution of a species or a group of closely related species.
3) Useful for evolutionary studies. Morphological comparison of living and fossil species with their close and distant relatives is needed to interpret the trends of changes during the course of evolution.
4) Useful for studies of life history. Specimens of different ages and sexes of a species and from different times of the year should be included to illustrate their development through life.
5) Useful for ecological studies. All specimens and their accompanying collecting data are historical records of the animals and thereby demonstrate the environmental conditions under which a species may live.

MATERIALS FOR DISPLAY AND EDUCATION

Display is an effective vehicle for dissemination of knowledge to the general public. A proper selection of display material not only improves the credibility of the information presented but also increases the acceptability to viewers. A special assemblage of specimens can be used at different educational levels to complement textbooks.

REFERENCE COLLECTIONS

These are special collections containing sets of properly identified specimens. The informed public should have access to such collections to help to identify their specimens or to verify their identification.

FAUNAL ASSEMBLAGE COLLECTIONS

Most materials in a natural history museum are sorted to groups or species. Some samples, for instance plankton and benthos, should be kept intact to illustrate the community structure of a fauna at the time of collection.

VOUCHER COLLECTIONS

Voucher specimens are examples of species identified by an individual in the course of a study. They should be kept so that, as taxonomy and nomenclature change, it is always possible for future investigators to check the identity of the specimens at some later date.

It is by possessing and maintaining such diverse and extensive collections that a natural history museum can demonstrate, promote interest in, and disseminate knowledge about the heterogeneity of nature to the community it serves.

MISCELLANEOUS / DIVERS

THE INVOLVEMENT OF THE INTERNATIONAL COUNCIL OF MUSEUMS IN COLLECTION'S MANAGEMENT

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LEMIEUX, L. 1983. The involvement of the International Council of Museums in collection's management. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 173.

ABSTRACT- Several international bodies, such as the United Nations' Educational Scientific and Cultural Organization (UNESCO) and the International Council of Museums (ICOM) are interested and concerned about collections' management. They would like to see published, eventually, a manual of techniques and procedures applied to natural history collections; such a manual would be distributed internationally and would be up-dated periodically. UNESCO would probably contribute financially to the production of such a publication. This Ottawa meeting on the care and maintenance of natural history collections is addressing an important series of problems of national and international concern and will be followed with much interest.

RESUME- Plusieurs organismes internationaux comme l'"Organisation des Nations unies pour l'éducation, la science et la culture" (U.N.E.S.C.O.) et le Conseil international des musées (ICOM) s'intéressent à la gestion des collections et s'en préoccupent. Ils souhaitent que l'on dispose un jour d'un manuel des techniques et méthodes appliquées aux collections d'histoire naturelle; ce manuel aurait une diffusion internationale et serait mis à jour régulièrement. L'U.N.E.S.C.O. contribuerait probablement au financement de cette publication. La réunion consacrée aux soins et à l'entretien des collections d'histoire naturelle qui se tiendra à Ottawa portera sur de nombreuses questions d'importance nationale et internationale et suscitera sans doute un vif intérêt.

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MISCELLANEOUS / DIVERS

TECHNIQUES TO RESTORE DRIED-UP INVERTEBRATE SPECIMENS

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MARHUE, L. 1983. Techniques to restore dried-up invertebrate specimens. In: Proc. of 1981 Workshop on the Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 175-177.

ABSTRACT- Dried-up invertebrate specimens are often found in large collections. Restoration of specimens to their original state of preservation is impossible but sometimes these animals are valuable enough to spend time to restore them to a state useful for reference and even taxonomic purposes. Three techniques to restore dried-up specimens are presented.

RESUME- Les grandes collections rassemblent souvent des spécimens d'invertébrés desséchés. Il est impossible de redonner à ces spécimens leur apparence originale. Dans certains cas, les animaux ont suffisamment de valeur pour que l'on consacre un certain temps à leur remise en état pour les utiliser à des fins de référence et même de taxinomie. L'article expose trois techniques de restauration des spécimens desséchés.

INTRODUCTION

The problem of evaporation of spirits from jars or vials containing biological specimens continually plagues museums and other institutions responsible for long-term storage of wet collections. As a result of evaporation, many hours are spent topping up bottles and jars. In an attempt to prevent collections from drying-out, much time has been spent on designing different types of covers and tops for bottles; some are more successful than others. Various glycols have been used as additives so, in the event of complete evaporation of the preservative, some flexibility is still maintained in tissues and joints of arthropods and other kinds of invertebrates. Both ethylene glycol and propylene glycol have been used.

Despite all precautions taken, important collections are still allowed to sit several years without being checked for evaporation of preserving solutions. Collections become partially or even completely dried-out as a result of such "neglect". In this dried-out state they possess little value to the organization that owns them or to anyone wishing to examine them. Restoration of specimens to their original state is virtually impossible but sometimes invertebrate animals can be restored to a state that is usable for taxonomic and reference purposes. Important heritage collections are sometimes discarded because of a lack of knowledge of techniques which can restore dried-up specimens.

The invertebrate Zoology Division recently acquired an extensive collection of various kinds of invertebrates collected from the arctic and over 20 percent of the crustacean collection was dried-out. Because of the heritage value and rarity of many of these specimens, attempts are under way to reconstitute this collection to at least a partially useable condition. Various restoration techniques are being tested.

PROPYLENE GLYCOL TECHNIQUE

Dried-out specimens of Crustacea were allowed to soak in 50% propylene glycol and 50% distilled water for 24 hours. Examination of the specimens after 24 hours indicated that most mouthparts and other appendages were able to be moved without breaking. Propylene glycol was chosen over ethylene glycol because of the hazard to users of the latter. Thompson *et al.* (1966) have outlined further details in the use of glycol to restore dried-up invertebrate specimens.

The use of ethylene glycol is now being discouraged because of the possibility that it may be absorbed through the skin or even accidentally ingested. It has been shown that ethylene glycol breaks down within the human body through oxalic and pyruvic acids. Since oxalic acid is very poisonous to humans at certain concentrations, it is wise to avoid its use. Since the crustacean collection of the National Museum of Natural Sciences is maintained in 75% ethyl alcohol with 2% propylene glycol, it is proposed that most dried-up specimens belonging to this collection can be treated with this technique.

TRISODIUM PHOSPHATE TECHNIQUE

Various specimens of decapods and pycnogonids were allowed to soak overnight in 0.5% commercial trisodium phosphate in distilled water. After only two hours in this solution, appreciable swelling of most specimens was evident. Our use of this method is based on a "rule of thumb" - the larger the specimen the longer it needs to soak. After soaking, specimens were transferred to 75% ethyl alcohol with 2% propylene glycol for long-term storage. Trisodium phosphate has been shown to successfully restore several types of invertebrates, including leeches (Hirudinea), Nematoda, Crustacea, Insecta and Mollusca (Van Cleave and Ross 1947). Success rate was shown to be high with both small and larger specimens. After treatment, soft parts were quite soft and flexible and appendages of certain crustaceans showed little danger of breaking off.

SURFACTANT TECHNIQUE

A third technique to restore dried-up invertebrate specimens involves the use of Decon 90[1] or Contrad 70[2], a highly effective surfactant. Although this technique has not as yet been used in our laboratory, it is useful to report this technique because of its strong potential and similarity to the previous two techniques. This technique is based upon a publication by Banks and Williams (1972) who used it to soften dry specimens of insects (coccids) and to remove wax and other secretions from the exoskeleton. Dried specimens were soaked in Decon 90 overnight or even less if specimens were small. After soaking, they were rinsed twice in distilled water and transferred to the preserving solution.

DISCUSSION

It is wasteful of time and money to discard dried-up specimens which can never be collected again. With the availability of these techniques for restoration, it is possible that many dried-up specimens of valuable invertebrate animals can be restored to a useable condition.

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[1] Decon 90 is the manufacturer's name for this cleaning agent (Decon Laboratories Ltd., Ellen Street Portslade, Brighton, Sussex, England, BN4 1EO).

[2] Contrad 70 is the North American distributor's name for this same cleaning agent (Harleco, 60th and Woodland Avenue, Philadelphia, PA 19143).

NATURAL HISTORY COLLECTIONS AT THE REGINA RESEARCH STATION

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MOLLOY, M. 1983. Natural history collections at the Regina Research Station. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 179-181.

ABSTRACT- The insect collection and herbarium at the Regina Research Station are used in the weed control work performed at the station. The herbarium contains mainly species of weeds although most Canadian herbaceous families are represented. The insect collection is maintained as part of the programme of biological control of weeds.

RESUME- La collection entomologique et l'herbier tenus par la Station de recherche de Regina sont mis à contribution pour de nombreuses études des moyens de lutte contre les mauvaises herbes. La collection entomologique exploite deux thèmes principaux: les insectes d'Europe, dans le cadre des études des moyens de lutte biologique, et les insectes d'Amérique du Nord, recueillis lors d'études des associations mauvaises herbes-insectes de grande envergure. Le présent article traite de certains détails d'entreposage et des applications pratiques des collections.

INTRODUCTION

The Regina Research Station is a centre for weed control in Canada. Areas of study include biological control of weeds, environmental quality, physiology and ecology of weeds.

The insect and herbarium collections reflect the functions of the station and are extensively used for identification of specimens brought in by agricultural workers and the general public. The insect collection is maintained as an integral part of the Biological Control of Weeds program in order to determine what insects may be on these weeds. The insect collection also contains representatives of species imported for testing and voucher specimens of those released in control programs. The herbarium contains mainly species of weeds although most Canadian herbaceous families are represented.

INSECT COLLECTION

The insect collection now contains about 1800 named species with several thousand specimens taken from more than 60 different plants. There are two main themes to this collection. One is European insects which are associated with Biological Control of Weeds Programs and second is North American insects which have been collected during weed/insect surveys. These weed/insect surveys were initiated to determine the types of native insects that are associated with introduced and native weed species. Collecting of native insects is done in the summer when plants under observation are swept or asperated and roots, leaves, stems and flowers, searched for miners, galls or pathogens. The majority of the insects in the collection have been taken in Saskatchewan.

This collection also houses European and certain other foreign insects. Biological control programmes use insects, pathogens, etc. to control or limit a target organism. After thorough testing under isolation conditions to insure safety, certain organism may be released in Canada. Voucher specimens of the species are kept in Regina, CNC-Ottawa and Washington D.C. There are numerous species in the collection that either failed the host tests, couldn't be propagated in the laboratory, or for some other reason were not released. Parasites, nematodes and other extraneous insects from European shipments are also preserved.

Most of the insects are pointed or pinned and there is a small collection of wet specimens, mostly immatures and spiders. (Adults of Lepidopteran are spread). At least once a year fresh moth crystals (Paradichloro - benzene 99%) are put in each drawer and the glass cleaned. Crystals are also put in empty drawers and Schmidt boxes.

HERBARIUM

This collection is used mainly as a reference collection by staff of Agriculture Canada, the Saskatchewan and Manitoba Dept. of Agricultures and local farmers. Current emphasis is on augmenting some of the older holdings and obtaining specimens of all North Temperate Zone weeds. Plant specimens are mounted with polyvinyl acetate and strips of cloth tape onto herbarium paper. These herbarium sheets are housed in metal cabinets in taxonomic order. They are mainly weed species of Western Canada, including native and cultivated species.

MISCELLANEOUS / DIVERS

Displays of common weeds effecting areas of Saskatchewan have been developed for various Winter Fairs. Mature plants were presented under mylar sheets for protection and weed seedlings were displayed in plastic mounts. (Molloy and Maw 1978).

INSECT CATALOGUING SYSTEM

There are three interrelated cataloguing files used presently to record species of insects that are collected. At the time of collection, data sheets are completed for each plant, noting date, locality, stage of weed, and collector. This data is transferred to insect labels for each insect obtained in this collection. Insects are placed in the collection of the station only if it is a new record for a species of plant.

INSECT/PLANT FILE

Each species of insect in the collection has a file card. On this card are noted the insect's taxonomic position and plant and province collected from. Notes of life history or other comments may be added. A code mark in the upper left corner indicates whether the insect was identified locally or by a specialist from CNC and if it is a European insect.

PLANT/INSECT FILE

These cards are filed by species of plant. All insects found on a particular plant are listed.

INSECT FILE

These cards are filed by orders. Presently, there are 180 species of Homoptera, 195 species of Lepidoptera, 478 species of Coleoptera, 145 species of Hemiptera, 20 species of Orthoptera, 551 species of Diptera, and 417 species of Hymenoptera; 1,986 species.

REFERENCE

Molloy, M.M. and M.G. Maw. 1979. Permanent weed seedling plastic mounts. Weeds Today 10(2): 23.

MISCELLANEOUS / DIVERS

COMPARISON OF ZOOARCHAEOLOGICAL AND CLASSICAL OSTEOLOGICAL COLLECTIONS

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RICK, A. 1983. Comparison of Zooarchaeological and classical osteological collections. Abstract of talk presented at Collection Workshop, Ottawa 27-28 May, 1981. In: Proc. of 1981 Workshop on Care and Maintenance of Natural History Collections, edited by D.J. Faber, *Syllogeus* No. 44: 183.

ABSTRACT- Zooarchaeological skeletal collections facilitate the study of animal remains from archaeological sites. Because they serve archaeology primarily they differ from traditional osteological collections in scope, arrangement, mode of preparation and amount of biological data recorded for each specimen. The large zooarchaeological reference collection (approx. 3000 specimens) of the National Museum of Natural Sciences is an example of such a collection. Differences between it and traditional zoological collections are discussed, and thoughts are offered on what a modern zooarchaeological collection should be.

RESUME- Les collections de squelettes zooarchéologiques facilitent l'étude des restes d'animaux provenant de sites archéologiques. Parce qu'elles sont surtout utiles à l'archéologie, elles diffèrent des collections ostéologiques classiques du point de vue de la portée, de la disposition, des méthodes de préparation et de la quantité de données biologiques relevée pour chaque spécimen. L'importante collection de référence zooarchéologique (qui contient environ 3 000 spécimens) du Musée national des sciences naturelles illustre bien ce type de collection. L'auteur traite des caractéristiques qui la distinguent des collections zoologiques classiques et se prononce au sujet de ce que devrait être une collection zooarchéologique moderne.

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APPENDIX A / ANNEXE A

APPENDIX A: SELECTED BIBLIOGRAPHY ON CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS.

This selected bibliography is based on a display of literature presented at the Workshop. These are manuals and published papers used by the curatorial staff of natural history museums. This is not a complete list on the subject. The objective of this list is to provide readers with a starting point and to bring to their attention some valuable references about curatorial techniques. This bibliography is divided into five sections: botanical, invertebrate, mineralogical, palaeontological and vertebrate collections.

Most of these books and articles in journals are obtainable by loan or purchase through a library or purchasing department. A book store can order "in print" copies. Articles in journals can be obtained either by purchasing the journal or writing to the author, who generally supplies reprints on request. I am grateful to staff of the National Museum of Natural Sciences who assisted me in compiling this bibliography.

M.J. Shchepanek

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Most of these books and articles in journals are obtainable by loan or purchase through a library or purchasing department. A book store can order "in print" copies. Articles in journals can be obtained either by purchasing the journal or writing to the author, who generally supplies reprints on request. I am grateful to staff of the National Museum of Natural Sciences who assisted me in compiling this bibliography.

M.J. Shchepanek

APPENDIX A / ANNEXE A

ANNEXE A: BIBLIOGRAPHIE SELECTIVE SUR LA PREPARATION ET LA PRESERVATION DES COLLECTIONS D'HISTOIRE NATURELLE

Cette bibliographie sélective a été établie à partir d'un éventail de documents présentés lors de l'Atelier. Ces guides et ces rapports constituent une partie des références consultées par les conservateurs de musées d'histoire naturelle. Il ne s'agit pas d'une liste exhaustive, mais bien d'un point de départ pour attirer l'attention du lecteur sur des publications sérieuses portant sur des méthodes de conservation. Cette bibliographie se divise en cinq parties qui ont trait, respectivement, aux collections de botanique, d'invertébrés, de minéralogie, de paléontologie et de vertébrés.

On peut se procurer la plupart des livres et des articles de revue cités en ayant recours au service des achats ou à la bibliothèque, selon qu'on veuille les acheter ou les emprunter. Un libraire peut commander des exemplaires encore sous presse. Pour un article en particulier, on peut faire acquisition de la revue qui le publie ou encore écrire à l'auteur, qui est généralement en mesure de fournir des tirés à part sur demande. Je tiens à exprimer ma reconnaissance au personnel du Musée national des sciences naturelles qui m'a aidé à compiler la présente bibliographie.

M.J. Shchepanek

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APPENDIX B / ANNEXE B

APPENDIX B: REPORT ON QUESTIONNAIRE CONCERNING CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS.

Approximately 500 questionnaires were sent across Canada to all museums with natural history collections, to herbaria, to entomological collections, to paleontological collections, to geological collections and to all universities.

QUESTION 1: Are you interested in developing contacts with other persons maintaining natural history collections?

Replies by province

	Yes	No		Yes	No
Ontario	59	-	Saskatchewan	6	-
British Columbia	21	-	Nova Scotia	5	-
Alberta	19	-	Newfoundland	3	-
Québec	15	-	N.W. Territories	2	-
Manitoba	10	-	USA	1	-
New Brunswick	6	-			

TOTAL Yes: 147 No: -

Replies by agency

Federal government agencies	50
Provincial government agencies	41
Universities	34
Other agencies	22

QUESTION 2: Would you be interested in attending local or regional meetings with other persons maintaining such collections? 127 Yes, 20 No.

QUESTION 3: Would you subscribe to a Canadian newsletter presenting news and views about care of natural history collections? 129 Yes, 18 No.

QUESTION 4: Which two or three of the five topics interest you most? (1. Collection, 2. Preservation, 3. Preparation, 4. Documentation, 5 Storage).

1. Collection	59
2. Preservation	69
3. Preparation	56
4. Documentation	60
5. Storage	69

Comments on the Survey

The results of the survey and comments that accompanied replies showed that there is considerable interest, but little research activity in the area. Most of those who replied were interested in learning about new techniques, but few offered to show new methods they had developed. The results of Questions 1 and 2 suggest that there are enough interested persons to meet locally or regionally in Ontario, British Columbia, Alberta, and Manitoba. A significant proportion of those replying indicated they would be interested in meeting regularly, but travel costs were the major concern. The replies received were almost equally divided among federal and provincial agencies and universities. A large number of those replying indicated an interest in a Canadian Newsletter (Question 3).

D.J. Faber and G.R. Fitzgerald

APPENDIX B / ANNEXE B

ANNEXE B: COMPTE RENDU DU SONDAGE SUR LA PREPARATION ET LA CONSERVATION DES COLLECTIONS D'HISTOIRE NATURELLE

On a envoyé quelque 500 questionnaires d'un bout à l'autre du Canada à tous les musées possédant une collection d'histoire naturelle, aux établissements dotés d'un herbier, d'une collection entomologique, paléontologique ou minéralogique ainsi qu'à toutes les universités.

QUESTION 1: Etes-vous intéressé à communiquer avec d'autres gens qui prennent soin des collections d'histoire naturelle?

Réponses affirmatives, par zone géographique

Ontario	59
Colombie-Britannique	21
Alberta	19
Québec	15
Manitoba	10
Nouveau-Brunswick	6
Saskatchewan	6
Nouvelle-Ecosse	5
Terre-Neuve	3
Territoire du Nord-Ouest	2
Etats-Unis	1

Total 147

Réponses affirmatives, par type d'établissement

Organismes du gouvernement fédéral	50
Organismes d'un gouvernement provincial	41
Universités	34
Autres établissements	22

QUESTION 2: Etes-vous intéressé à assister à des réunions régionales ou locales avec d'autres personnes qui prennent soin de telles collections? Oui: 127, Non: 20

QUESTION 3: Seriez-vous intéressé à recevoir un bulletin d'information portant sur l'entretien des collections d'histoire naturelle? Oui: 129, Non: 18

QUESTION 4: Auquel des sujets suivants vous intéressez-vous surtout? (1. Cueillette; 2. Préservation; 3. Préparation; 4. Rangement; 5. Soin des spécimens)

1. Cueillette	59
2. Préservation	69
3. Préparation	56
4. Rangement (fr.) - documentation (angl.)[1]	60
5. Soin des spécimens (fr.) - storage (angl.)[1]	69

Commentaires sur le sondage

Les résultats du sondage et les commentaires accompagnant les réponses indiquent qu'il y a un intérêt considérable pour le domaine, mais qu'il s'y fait peu de recherches. La plupart des répondants apprendraient volontiers de nouvelles techniques, mais bien peu se sont offerts pour expliquer les méthodes qu'ils avaient eux-mêmes mises au point.

Les réponses aux questions 1 et 2 démontrent qu'il y a suffisamment d'intéressés en Ontario, en Colombie-Britannique, en Alberta et au Manitoba, pour tenir des réunions à l'échelle régionale ou locale. Une bonne proportion des répondants ont exprimé la désir de se réunir régulièrement, mais ont soulevé le problème des frais de déplacement. Les réponses émanaient en proportion presque égale d'organismes gouvernementaux (fédéraux et provinciaux) et d'universités. A la question 3, un grand nombre de répondants ont indiqué qu'ils aimeraient recevoir un bulletin canadien d'information sur l'entretien des collections.

D.J. Faber et G.R. Fitzgerald

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[1] Les questions ne sont pas les mêmes en anglais et en français.

RECENT SYLLOGEUS TITLES / TITRES RECENTS DANS LA COLLECTION SYLLOGEUS

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